The Engineer

LONDON, FRIDAY, SEPTEMBER 5, 1941.

PUBLIC NOTICES

BOROUGH OF CHEPPING WYCOMBE

WATER DEPARTMENT

NEW PUMPING PLANT AT PANN MILL

The Corporation of the above Borough invite TENDERS from experienced Engineering Firms for the SUPPLY and INSTALLATION of an ADDITIONAL CENTRIFUGAL BOREHOLE PUMP and ELECTRIC MOTOR, to pump 160,000 g.p.h., together with the necessary CONTROL and SWITCHGEAR, PIPEWORK, and VALVES, &c.

Copies of the specification, bill of quantities, drawing, and form of Tender may be obtained from the Borough Water Engineer's Office, 70-71, Easton Street, High Wycombe, on payment of Two Guineas, which will be returned upon the receipt of a bona-fide Tender.

Sealed Tenders, endorsed "Tender for New Pumping Plant," to be delivered to the undersigned not later than 12 Noon on 22nd September, 1941.

The Corporation do not bind themselves to accept the lowest or any Tender.

S. YOUNG, A. Inst. W.E.,
Borough Water Engineer.

70-71, Easton Street,
High Wycombe,
Bucks,
August, 1941. 7724

BOROUGH OF CHEPPING WYCOMBE

WATER DEPARTMENT

REINFORCED CONCRETE CONTACT TANK AND ANCILLARY WORK

The Corporation of the above Borough invite TENDERS for the CONSTRUCTION of a COVERED REINFORCED CONCRETE CONTACT TANK to contain 217,000 gallons, together with TREATMENT HOUSE, VENTILATING HOUSES, &c., to be erected adjacent to the Pann Mill Pumping Station, High Wycombe.

Only Contractors experienced in this class of work are invited to tender, and they must have undertaken similar work for a period of at least three years, and it is requested that particulars of three examples of similar work which they have carried out be furnished.

Copies of the specification, bill of quantities, and form of Tender may be obtained from the Borough Water Engineer's Office, 70-71, Easton Street, High Wycombe, on payment of Two Guineas, which will be refunded on receipt of a bona-fide Tender.

Drawings of the above scheme may be examined during office hours.

Sealed Tenders, endorsed "Tender for Contact Tank, &c.," to be delivered to the undersigned not later than 12 Noon, 22nd September, 1941.

The Corporation do not bind themselves to accept the lowest or any Tender.

S. YOUNG, A. Inst. W.E.,
Borough Water Engineer.

70-71, Easton Street,
High Wycombe,
Bucks,
August, 1941. 7725

ESSEX RIVERS CATCHMENT BOARD

APPOINTMENT OF DEPUTY ENGINEER

Applications are Invited for the above APPOINTMENT. Commencing salary £500 per annum, rising by annual increments of £25 to £700 per annum, subject to satisfactory service.

The appointment will be subject to the provisions of the Local Government and Other Officers' Superannuation Acts, 1922 and 1937, and the successful candidate will be required to pass a medical examination.

Form of application may be obtained from the undersigned on receipt of a stamped addressed envelope. Completed forms of application must reach the undersigned not later than Friday, 12th September, 1941.

W. J. S. BEW,
Clerk of the Board.

Essex Rivers House,
Springfield Road,
Chelmsford,
26th August, 1941. 7736

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

TO ADVERTISERS UNDER BOX NUMBERS IN SITUATIONS OPEN SECTION.

For the benefit of applicants, the Proprietors are prepared to insert brief notices that vacancies are filled, upon receipt of notifications from the Advertisers. These notices (limited to one line) will be free of charge, and co-operation is asked for.

IMPORTANT

Advertisers in Situations Open Colum should make themselves acquainted wit the terms of

STATUTORY RULES & ORDERS 1940 No. 877

RESTRICTION ON ENGAGEMENT ORDE

APPLICATIONS are INVITED for APPOINTMENT of TRADE SCHOOL MASTER for large factory in outer London area. Applicants should have practical workshop experience and be capable of teaching Mathematics, English and Geography to youths between 14 and 18 years of age. Generous commencing salary and steady advancement for selected applicant.—Address, stating age, education, qualifications and full particulars, with recent photograph, if possible, 7744, The Engineer Office. 7744 A

CHIEF ENGINEER REQUIRED, to Take Charge of Department for protected establishment manufacturing a wide variety of products. Must be fully conversant with Steam-raising and Electrical Plant, Maintenance of Pumps, Vacuum Plant and many varieties of Small Apparatus. Age preferably between 35/45. Permanent position with prospects of advancement.—Write, giving full details of experience, qualifications, salary required, &c., to ALLEN & HANBURYS, Ltd., Ware, Herts. 7742 A

The Engineer

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PAPER ECONOMY

It has now become necessary, in order to maintain the normal circulation of THE ENGINEER, to print all advertisement pages on the Thin Paper hitherto used for the Foreign Edition.

So long as our diminishing stocks of thick paper will allow, the Home Edition Editorial pages will be printed on the usual paper, so that uniformity in bound volumes may be maintained.

SITUATIONS OPEN

CRAVEN BROTHERS (MANCHESTER), LIMITED, Machine Tool Makers, REQUIRE GENERAL ERECTION SHOPS SUPERINTENDENT at their main Stockport Works.

This is an executive position which carries considerable responsibility and post-war prospects.

Apply in first instance by letter to the MANAGING DIRECTOR, stating full details of experience, age and when at liberty. 7750 A

METALLURGICAL CHEMIST, Male, REQUIRED by Engineers in Letchworth, experienced in the Manufacture of Welding Electrodes and capable of Controlling Laboratory. Salary £300 per annum upwards, according to qualifications.—Apply in writing, stating if registered at any office of the Ministry of Labour and National Service, to the SUPPLEMENTARY REGISTER, 4, Gt. Marlborough Street, London, W.1, quoting order No. M838. 7740 A

SALES ENGINEER REQUIRED by Leading Manufacturers of Builders' and Contractors' Plant and Road Building Machinery, to Assist in Sales, Promotional Research and Planning. Applicants, not liable for military service, should have sound engineering training and good selling experience and record, preferably in civil engineering and contracting trades. State age, education, experience and salary required.—Address, 7733, The Engineer Office. 7733 A

SITUATIONS OPEN

PROMINENT CONTRACTORS REQUIRE Capable AGENT to Take Charge of Reconstruction Work in North-West area. Must be used control of men. Excellent prospects.—Address, 7696, The Engineer Office. 7696 A

SHIFT ENGINEER REQUIRED, Thoroughly qualified to take shift charge of high-pressure steam-raising plant, turbo-generators and all auxiliaries. Permanent appointment in Home Counties. Salary £366 per annum. Pension scheme. Address, stating age, experience and enclosing copies of testimonials, 7720, The Engineer Office. 7720 A

THE Post You Are Seeking May Not be Advertised in this Column, but do not lose the Opportunity of Bringing Your Requirements before all those who would be interested and could employ you. An Advertisement in the "Situations Wanted" Column would be seen by all Leading Engineering Concerns for a cost of Four Lines, 4s.; 1s. for each Additional Line. There is no better way of covering so large a field for such a small charge.

FOREMEN REQUIRED, Experienced in Laying Steel Pipe Lines and Installation of Pumps. Must be willing to travel.—Address, stating experience and salary required, P3466, The Engineer Office. P3466 A

SITUATIONS OPEN

THE STANTON IRONWORKS COMPANY, Limited, near Nottingham, invite APPLICATIONS for the POSITION of CHIEF ENGINEER, to Take Charge of Maintenance and Development of Five Separate Works, embracing blast-furnaces, and foundries, but specialised knowledge not essential.—Apply to the MANAGING DIRECTOR, at above address, stating experience and present salary. 7718 A

SITUATIONS WANTED

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CIVIL ENGINEER, A.M.I.C.E., M.I.M.E., DESIRES CHANGE. Experience railways, factory lay-out, surveying; wide mechanical knowledge. Salary £1000.—Address, P3452, The Engineer Office. P3452 B

CIVIL ENGINEER, Just Returned from Middle East from two years' contract, DESIRES POSITION. First-class man. Age 36 years.—Address, P3494, The Engineer Office. P3494 B

CONTRACTS and SALES MANAGER, B.Sc., First-class Hons., A.M.I.E.E., A.M.I. Mech. E., age 33, 12 years' extensive technical and commercial experience in the design, construction, sales and operation of a large range of engineering products, including high-pressure water-tube boilers, electrical generators, buildings and civil engineering work, fully qualified to take control of sales, contracts and estimating departments, experience abroad, SEEKS alternative POSITION.—Address, P3491, The Engineer Office. P3491 B

ENERGETIC BUSINESS MAN, Age 48, Extensive workshop, commercial, buying and selling experience, SEEKS WHOLE or PART-TIME ENGAGEMENT, placing sub-contracts, progressing deliveries, liaison work, &c., or similar, based on London. Nominal remuneration.—Address, P3476, The Engineer Office. P3476 B

ENGINEER, Aged 45, SEEKS CHANGE; Present position 10 years' experienced factory plant maintenance and its erection.—Address, P3497, The Engineer Office. P3497 B

ENGINEER DESIRES CHANGE. Experience in heavy Diesel engines, A.C. and D.C. gen., pumps, maintenance and all workshop practice. Preferably abroad.—Address, P3495, The Engineer Office. P3495 B

EXPERIENCED ENGINEER, with Long Training as general manager, SEEKS ADMINISTRATIVE POST; successful technical and commercial experience.—Address, P3487, The Engineer Office. P3487 B

METALLURGIST, with 21 Years' Practical Experience of seamless steel tube production and manipulation of stainless and other alloy steels, DESIRES RESPONSIBLE POSITION with a progressive firm.—Address, P3496, The Engineer Office. P3496 B

GENERAL MANAGER and CHIEF ENGINEER (50), M.I. Mech. E., of proved commercial, technical and organising ability, with successful record, is now free to take up any suitable POST where business and economic production development is required. Has successfully controlled large and medium-size works employing male and female labour on Government contracts. Thoroughly conversant with M.O.S., Admiralty and M.A.P. contracts procedure. Highest credentials. Would accept a moderate salary for progressive post with good prospects on really satisfactory results.—Address, P3486, The Engineer Office. P3486 B

GENERAL or WORKS MANAGER, Age 38, REQUIRES POST with Light Engineering Company. Thorough experience of factory management, planning, costing and all modern production methods.—Address, P3492, The Engineer Office. P3492 B

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IF the Man You Are Seeking is Not Amongst those Advertising in this Column, a Small Announcement in the "Situations Open" Column will Quickly and Economically Produce the Right Selection of Applicants, at the same time Eliminating Waste of Effort, Waste of Time, and Waste of Opportunity. The charge is Four Lines or under, 4s.; each Additional Line, 1s.; Box Numbers, 6d. extra, which includes despatch of all replies.

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CLASSIFIED ADVERTISEMENTS CLOSE FOR
PRESS—NOON WEDNESDAYS

The Engineer

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(including postal charges)

Le prix de l'abonnement est accepté en livres sterling, ou dans la monnaie du pays d'origine au cours du change au moment de la commande.

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BUENOS AIRES: F. W. Mole, Cangallo, 456

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STOCKHOLM: A/B C. E. Fritzes Kungl., Hofbokhandel Fredsgatan, 2

SWITZERLAND ZURICH: Rosa Leibowicz, 4, Ankerstr.

UNITED STATES OF AMERICA NEW YORK: International News Co., 131, Varick Street, New York, N.Y., and all Branches
Moore Cottrell Subscription Agency, North Cohocton
BOSTON: F. W. Faxon and Co., 63–69, Francis Street

Entered as second-class matter at the Post Office, New York, N.Y., December 12th, 1896, under the Act of March 3rd, 1879 (Section 397, P.L. & R.).

U.S.S.R. ... ... LENINGRAD: Meshdunarodnaja Kniga, Prospect Volodarsky, 53A
MOSCOW: Kuznetski Most 18

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PAPER SUPPLIES

With a view to the conservation of paper, readers are advised, in the interests of all concerned, to place a regular order for THE ENGINEER with their newsagent or direct with the Publisher.

"THE METALLURGIST"

This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER each alternate month. Next due, October 31st.

ADVERTISEMENTS

The charges for Classified Advertisements are 1/- per line up to one inch—minimum charge 4/-; those occupying one inch or more at the rate of 12/- per inch. Orders must be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified Advertisements cannot be inserted unless delivered before TWO o'clock on Wednesday afternoon.

Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

Postal Address, 36, Essex Street, Strand, London, W.C.2. Teleg. Address, "Engineer Newspaper, Estrand, London." Tel., Central 6565 (10 lines).

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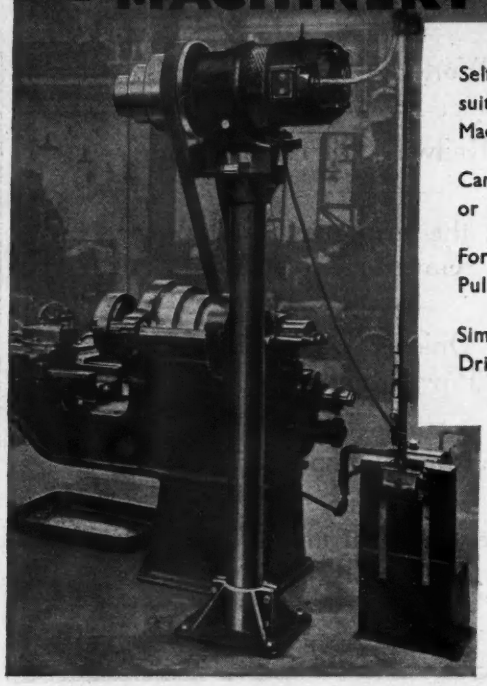

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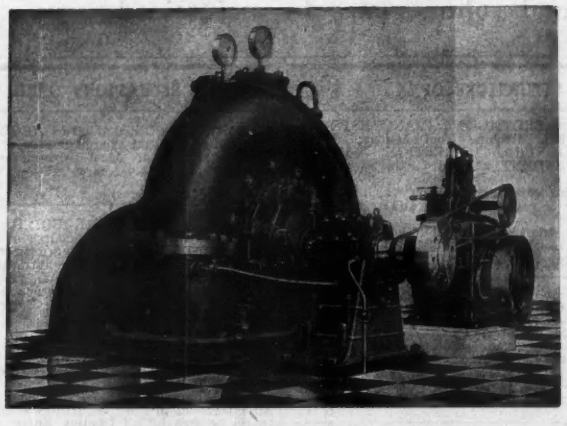

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M.A.P. CONTRACTORS. — Experienced ORGANISER, engineer, SEEKS POSITION as General or Commercial Manager with engineering firm engaged in M.A.P., Admiralty or M.O.S. work. First-class references.—Address, P3484, The Engineer Office. P3484 B

METALLURGIST, WORKS CHEMIST, DESIRES CHANGE; 20 years' practical experience in heat treatment, laboratory and process control in engineering, press shop and foundry work.—Address, P3493, The Engineer Office. P3493 B

YOUNG ENGINEER, Age 30, With Wide Experience, REQUIRES RESPONSIBLE POSITION.—Address, P3465, The Engineer Office. P3465 B

DRAUGHTSMAN, Engineering Degree, 5 Years' experience, including structural design (R.C. and steel work), electro-chemical plant lay-out and design, pipe work, gas compressing plant lay-out and light mechanical engineering, SEEKS POSITION, preferably London or district.—Address, P3488, The Engineer Office. P3488 B

PARTNERSHIPS

BUSINESS MAN WISHES to INVEST CAPITAL and TAKE ACTIVE INTEREST in small Engineering Concern at present doing work of national importance. Has ideas how to continue plant after the war.—Box 2718, Collins' Advertising, 26, Mortimer Street, W.1. P3485 C

MISCELLANEOUS

INVENTORS.—A Well-known and Responsible ENGINEERING COMPANY SEEK NEW INVENTIONS and PRODUCTS in all branches of industry for development and production.—Communicate in first instance with Messrs. ERNEST W. HADEN & STRETTON, Solicitors, Bridge Street, Walsall, Staffs. P3429 I

For continuation of Small Advertisements see page 76

Vertical Milling Machines

all geared, hardened and ground throughout, ball and roller bearings, swivelling head, 30" x 8" Table

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ENGINEER HOME GUARDS!

Do YOU know—

What pressure is developed in a rifle barrel when a round is fired?

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A Seven-Day Journal

Government Control of Railways

IN view of the Government's decision to introduce legislation putting all public utility undertakings upon the same basis as regards war damage and in pursuance of the policy announced in the Budget speech of minimising the impact of increased costs of transport upon the prices of essential goods and services, the Government and the four main line railway companies and the London Passenger Transport Board have agreed that the existing financial arrangements relating to the control of the railways require to be modified and negotiations have proceeded accordingly. The Minister of War Transport announced last week that agreement had been reached. The revised arrangements, which will operate from January 1st, 1941, and will be continued for a minimum period of one year after the cessation of hostilities, provide for a fixed annual payment by the Government to the five controlled undertakings of £43 millions, to be divided among them approximately as follows:—Great Western Railway, £6,669,000; London and North-Eastern Railway, £10,148,000; London Midland and Scottish Railway, £14,736,000; Southern Railway, £6,607,000; and London Passenger Transport Board, £4,840,000. This sum is exclusive of (*a*) the net amount required for interest on capital issued and capital redeemed after the basic period of the original agreement (that is, after the end of 1937 in the case of the main line companies and after June, 1939, in the case of the Board); and (*b*) the net revenue derived from investments in road transport undertakings and from ownership of and investments in railways in Northern Ireland and Eire. Under the revised arrangements war damage to the railways will, as from commencement of control, be dealt with under the scheme to be introduced by the Government for public utilities generally. Corresponding adjustments in the financial terms relating to certain minor railways are under negotiation.

Representatives of British Industry to Visit America

As has already been announced in the House of Commons, a mission representing both the management and the labour sides of British industry is to visit the United States at the invitation of the Council of the Office of Production Management, for the purpose of making a tour of the defence industries. It is proposed that the mission shall arrive in the United States next month. The members are, for management:—Mr. F. C. Braby, managing director, Frederick Braby and Co., Ltd.; Mr. C. K. F. Hague, director, Babcock and Wilcox, Ltd.; Mr. C. P. Lister, chairman and managing director, R. A. Lister and Co., Ltd.; and Mr. J. S. Turner, managing director, Moira Colliery, Ltd.; and for labour, Mr. A. A. H. Findlay, United Patternmakers' Association; Mr. G. A. Isaacs, National Society of Operative Printers and Assistants; Mr. J. Kaylor, Amalgamated Engineering Union; and Mr. W. Lawther, Mineworkers' Federation of Great Britain.

Skilled Men in the Services

THE Committee on Skilled Men in the Services, Chairman, Sir William Beveridge, concludes in an Interim Report that the necessary work of modification, repair, maintenance and servicing of machines and instruments of war is now being performed, both in the Army and in the Air Force, with a notable economy of skilled men, secured by a high degree of dilution and extensive and well-designed arrangements for training. Vigorous efforts are being made by the Services to discover men already in the Forces not already engaged on such work, whose qualifications make it likely that they could undertake it with success or could be trained to do so. But in view of the military programmes a large increase of men engaged on such work is inevitable, exceeding the numbers who can be obtained within the Services by training or transfer. In the light of these considerations the Committee is satisfied that a further substantial withdrawal of skilled men in the engineering and allied industries from civil employment is required, and should be met by a corresponding extension of dilution in civilian industry. In respect of the Navy, information at the moment is less than it is in respect of the Army and the Air Force, but with the development of war at sea the time has come when substantial addition to the recruiting of men already skilled, for the Navy as for the other Services, has become inevitable. There is little risk of error in providing, for the Navy as for the Army, by November 1st, 1941, 50 per cent. of the requirements from June 1st to December 31st, 1941, for skilled men in engineering and allied trades. There are thousands of men of military age doing clerical, storekeeping and other light work in the Services, which could be done by women or by older men, but for which women or older men, for one reason or another, have not yet been made available. The Committee is aware that extensive plans have been prepared in the Service Departments for substitution of women for men in all suitable kinds of work, but until these plans are realised, and so long as men of military age are used on work within the capacity of others, whether with or against the will of the Service Departments, the Government will not escape criticism for waste of man power.

The Late Brigadier-General C. H. Mitchell

ENGINEERS in this country as well as in Canada and the other Dominions will learn with regret of the death of Brigadier-General Charles Hamilton Mitchell, which took place at Toronto on August 26th. He was born in 1872 and was educated at Toronto University. After qualifying as a civil engineer he became City Engineer, Niagara Falls, in 1894, and from 1901 to 1905 was assistant engineer to the Ontario Power Company, of Niagara Falls. From 1906 General Mitchell was engaged as a consultant on many Canadian hydro-electric projects and was often employed by the Canadian Government and by the Governments of Canadian Provinces on matters relating to water power. He served on several arbitrations and on the Royal Commission on Ontario Hydro-radial Railways. In 1924 he was appointed to the International Joint Board of Engineers on the St. Lawrence waterway project. General Mitchell became an officer in the Militia Service of Canada in 1899 and during the last war served as General Staff Officer (Intelligence) with the 1st Canadian Division, Canadian Corps, 2nd (Imperial) Army, and also at the War Office. He was awarded the D.S.O. in 1916. In 1917 he was made C.M.G., and a year later was created C.B. As well as holding the honorary degrees of LL.D. and D.Eng., he was a member of the Institution of Civil Engineers and of the American Society of Civil Engineers, and a Past-President of the Engineering Institute of Canada.

Record Aircraft Output

NOT only were more complete aircraft turned out by British firms last week, but a greater number of airframes, engines and accessories than in any equal period before. The rate of effecting repairs also reached a maximum. This achievement has caused the Minister of Aircraft Production, Lt.-Col. Moore-Brabazon, to send a letter of congratulation to all the firms concerned. It is especially noteworthy because the latest types of machines, bombers and fighters, being larger and more complex, absorb more man and machine hours to make than the smaller and simpler machines of the past. It is only necessary to consider the output of great four-engined bombers which are now being made in considerable numbers, or the new equipment of our latest fighters to appreciate the change that has taken place in no more than a few months. Moreover, it must not be forgotten that in some recent bombers and fighters the engines are considerably bigger than before. When these facts are taken into account it will be seen that the attainment of a record output, despite modifications of design which is a constant but unavoidable hindrance to production, shows that the aircraft industry has reached a very high standard of organisation.

Labour and the War Effort

OPENING the Trades Union Congress at Edinburgh on Monday last, the President, Mr. George Gibson, said that on the whole and to a marvellous extent the national effort had been a very good one. Let us give the Government due credit for its many far-reaching, positive achievements. We were striding, a little painfully, perhaps, the joints creaking and groaning here and there, but still striding along the high road to full industrial production. There was certainly no lack of good will on the part of the trade union movement of this country. It would do its part. Management, no less than labour, must do a good deal more to assist the production effort. Elementary common sense would seem to make it desirable that, when men and women were compelled to stand idle by their machines, they should be told of the difficulties, whatever they might be, that were responsible for the hold-up. Continuing, he said that it was not possible at this juncture to lay down any hard and fast plan for the world after the war. He saw no future for peace unless it was based on a return to the ancient virtues—the Christian virtues—of truth and love, of mutual help, of plain honest dealing between nation and nation, and as between man and man. The momentous joint declaration made by the President of the United States and the Prime Minister seemed admirably to fit in with those general principles.

Two Years of War

ON Wednesday last we had been two years at war with Germany, and the occasion was taken by the Forces to make brief statements on what had been accomplished in that period. The Admiralty announced that between the start of the war and August 1st this year over a thousand enemy aircraft had been destroyed or damaged by ships' gunfire and naval aircraft. Of that number, 537 were shot down into the sea and were known to have been destroyed with certainty. Merchant ships and fishing vessels accounted for 55 of these destroyed machines, minesweepers and other small naval vessels for 73, and the guns of H.M. ships for 275. Naval aircraft destroyed 122 enemy machines and allied naval vessels accounted for 12. The Royal Air Force during the two years has destroyed for certain 3900 enemy aircraft for a loss of 1400 fighters, the pilots of 450 being saved. An additional 600 machines have been destroyed by anti-aircraft defences under the control of Fighter Command. These figures exclude 3000 enemy machines destroyed in the Middle East, on the Western Front up to the time of Dunkirk, and in Norway and other theatres of war. Together, therefore, the Royal Air Force has accounted for the destruction of 7500 enemy aircraft for certain, in addition to the thousands destroyed on the ground or so damaged that they were of no further use. This year alone our fighters and guns have accounted for over a thousand German aircraft, 380 of them at night. Since the large-scale daylight offensive against the enemy in Northern France began on June 16th our day fighters have shot down 480 of the enemy's machines for a loss of 266 of ours. Fifteen of our fighter squadrons have now each shot down more than 100 enemy aircraft. One squadron of night "Beaufighters" has destroyed over 50 enemy bombers. On the purely naval side the German surface forces have been accounted for with the exception of the battleship "Tirpitz," the "Admiral Scheer," the "Admiral Hipper," three modern 6in. gun cruisers, two obsolete battleships and about a dozen first-class destroyers. The War Office statement says that in addition to building up a mighty Army at home, which has shielded us from invasion, we stand on guard at all points of the Empire. We have destroyed two Italian armies, totalling 550,000 men, and broken up Italy's East African Empire. We have removed the threat of an enemy Power being established on the Red Sea littoral and have reduced the enemy invaders of Cyrenaica to the defensive.

The T.U.C. Congress

THE Trades Union Congress made clear in several ways, on Tuesday last, the unalterable resolve of the British working class to pursue the struggle for the destruction of the Nazi-Fascist *régime*, and it pledged the trade union movement to give all possible help to Russia. It, furthermore, endorsed the proposal of the General Council for the establishment of an Anglo-Russian Trade Union Council composed of an equal number of representatives from both countries, and called on workers in all occupied countries to remain loyal to the "principles upon which the foundations of working-class liberty rest, and to hold themselves ready to strike with all their force against the common enemy, and meanwhile to do all they can to weaken and harass the Nazi invaders." In conveying greetings from the Labour Party to the Congress, Mr. C. R. Attlee uttered a warning against complacency. "Let no one doubt," he said, "that victory will call for our utmost exertions. There are some who do not realise to the full how dangerous are the times in which we live, and how strong is the enemy whom we have to fight. We must not be satisfied with our own efforts until all of us, in whatever sphere of life we work, are giving of our best. We must not for a moment allow ourselves to think that this war will be won by other people for us. We need a maximum effort by all."

The Convoy System

SOME figures disclosed during the week-end have shown not only the effectiveness of the convoy system, but the progress that is being made in the Battle of the Atlantic. It appears that since the beginning of the war only one ship in every two hundred and forty convoyed has been lost by enemy action. In the summer of 1940 the figure fell to one in six hundred and eighty-one British ships, whilst in the first ten months of the war only forty-seven merchant ships in convoy were sunk. The position, as everyone knows, got much worse when the attack was intensified early this year, but even so, for the whole period out of 240 ships in convoy 239 have reached port. There has recently been a great improvement, and it has been stated officially that the tonnage lost in July of this year was the lowest for the whole war, with the exception of two months last year, presumably March and April. A few days ago Mr. Alexander, the First Lord of the Admiralty, hinted that the figures for August looked like being at least equally good. Whether or not this improvement can be maintained remains to be seen, but what is at least certain is that for the time being the Battle of the Atlantic has taken a favourable turn, whilst the destruction of Axis ships continues to increase. It must not be forgotten that in the official figures of our *total* losses at sea are included those incurred by merchant ships during military operations, such as the evacuations of Dunkirk and Crete.

FAILURE OF TACOMA NARROWS BRIDGE, NOVEMBER 7TH, 1940

(For description see opposite page)

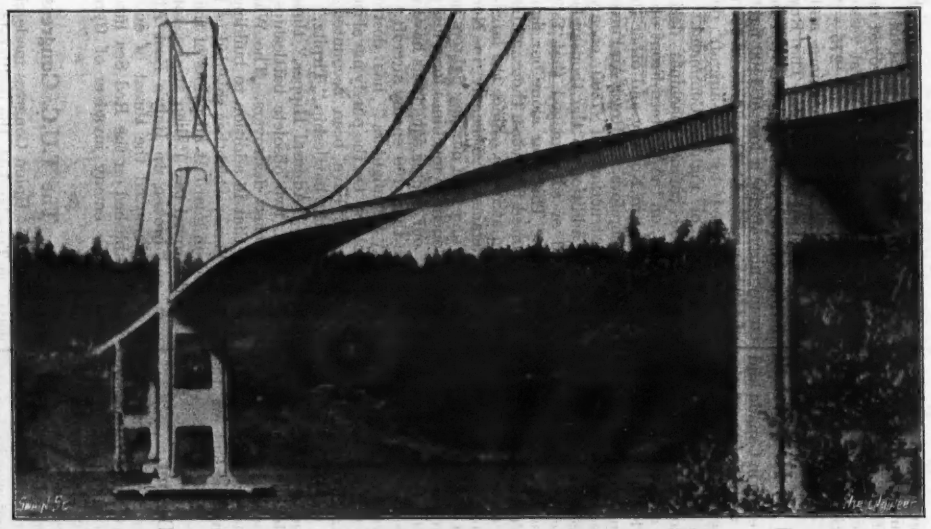


FIG. 8—TORSION OF FLOOR OF CENTRE SPAN ABOUT 10 A.M.
FIG. 10—FAILURE OF CONCRETE FLOOR ABOUT 10.30 A.M.

FIG. 9—TORSIONAL OSCILLATION OF CENTRE SPAN ABOUT 10 A.M.
FIG. 11—DROPPING OF 600FT. OF FLOOR STRUCTURE ABOUT 11 A.M.

Failure of Tacoma Bridge

No. II

(*Continued from page 130, August 29th*)

CONSTRUCTION AND BEHAVIOUR OF BRIDGE (*continued*)

Failure of the Bridge.—Prior to 10 a.m. on the day of failure, there were no recorded instances of the oscillations being otherwise than with the two cables in phase and with no torsional motions.

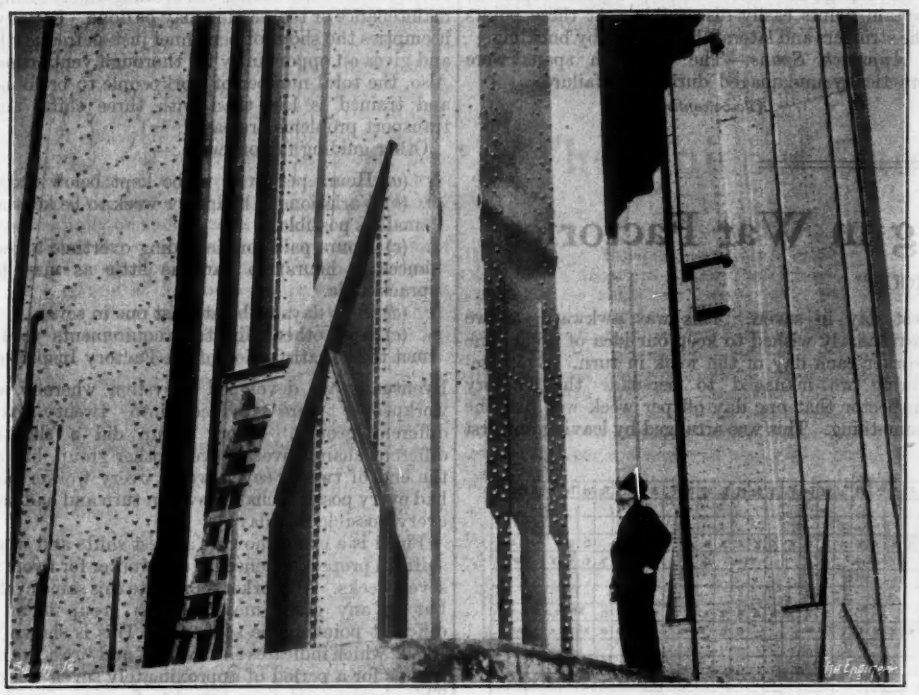


FIG. 12—BUCKLES ON SHOREWARD SIDE OF TOWER NEAR BASE

During the morning of November 7th the velocity of the wind was approximately 42 m.p.h., one of the most severe storms that had been experienced. Statements of witnesses indicate the following sequence of happenings.

Suddenly, at approximately 10 a.m., the centre span developed a torsional movement with a node at mid-span. The frequency suddenly changed from 37 to 14. At the quarter points the angle of rotation was observed as nearly 45 deg. each way,

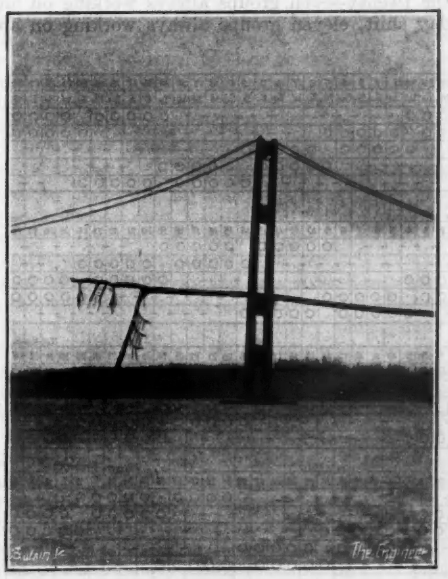


FIG. 13—FINAL STATE OF BRIDGE

the amplitude of the cable movement being approximately 28ft. Shortly after the start of this violent motion a differential motion between the concrete sidewalk slab and the girders was observed. The torsional movement at times changed to a different node, but soon returned to the single-noded motion. About 10.30 a section of the concrete roadway slab dropped from the centre of the bridge and photographs show a panel of laterals hanging from their centre connection.

The first major failure, the dropping of about 600ft. of the suspended structure at the Gig harbour (west) quarter point, occurred at about 11 a.m. With this failure the vibrations quieted down, but soon restored themselves. At 11.10 the final failure, consisting of the dropping of most of the remainder of the suspended structure in the centre span, occurred. With this release of weight in the centre span the side spans sagged and the towers were suddenly deflected shorewards, the maximum deflection being about 25ft.

During the violent motion of the centre span the east side span, presumably also the west side span, was relatively quiet. After the failure of the centre span a few torsional oscillations occurred in the east side span. During the failure there was a considerable slipping of the north cable through the centre cable band, which was held by the centre stays.

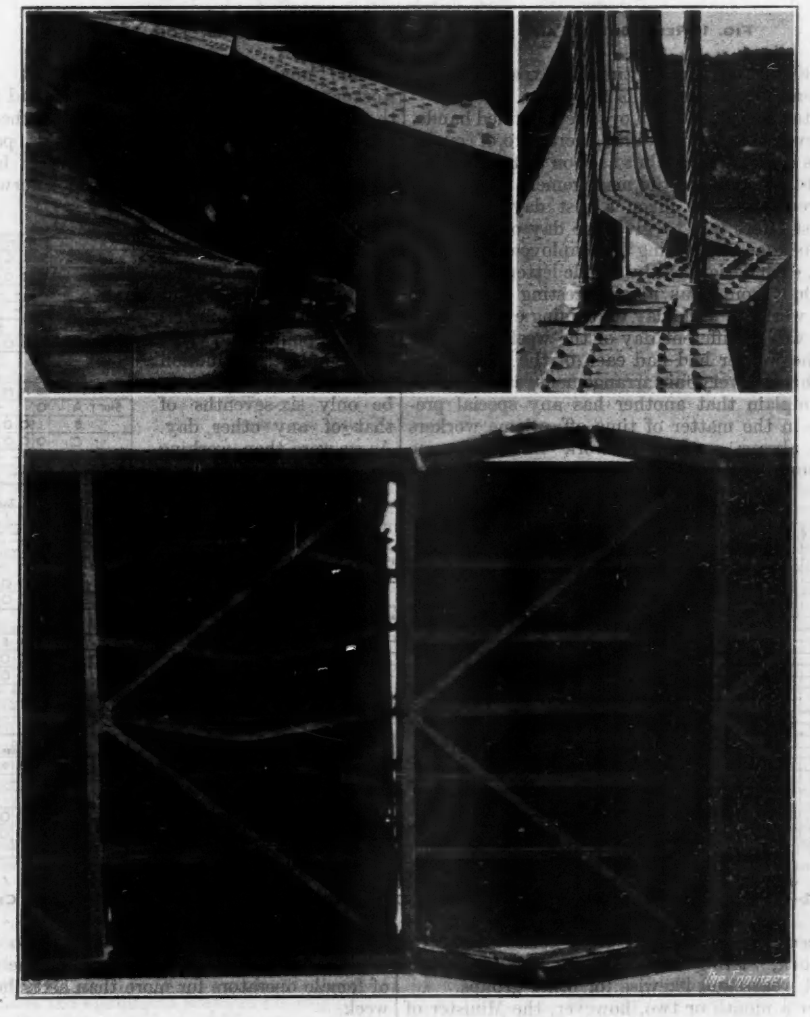
PHYSICAL CONDITION OF REMAINING PARTS OF THE STRUCTURE

As stated in the introduction, the Washington Toll Bridge Authority appointed a Board of Engineers to survey the physical condition of the remaining parts of the structure and to determine the amount of loss under the insurance on the structure. Our assignments did not include this question. On our visits to the site we made a superficial examination of the remaining parts. The results are summarised below.

FIG. 14—SIDE SPAN AFTER FAILURE

Anchorages.—There is no apparent damage to the anchorages. Mr. Eldred stated that a careful survey had indicated no movement.

Main Piers.—Aside from a small amount of



FIGS. 15, 16 AND 17—BUCKLING OF SUSPENDED FLOOR NEAR CENTRE OF SIDE SPAN

spalling of the concrete surrounding the channel connections to the tower anchorage grillage, there appears no damage to the main piers. Mr. Eldredge advised us that a survey had shown no displacements. We were further informed that the Toll Bridge Authority engineers are making periodic soundings to be certain that no undue amount of scour is taking place.

Towers.—The cover plates of the shoreward sections of all four tower shafts exhibit buckles throughout their entire height, indicating that these plates have been stressed beyond their yield strength. It is probable that some yielding has also taken place on adjacent parts. The splices on the channelward sections have yielded sufficiently to allow the joints to open. At the base the channelward sections lifted off the base plates. The top struts failed at their centre. Considering the severe bending of these towers during the failure of the bridge, there is a remarkably small amount of damage.

Cables.—At the centre of the north cable approximately 500 wires have been cut by the chafing of the centre cable band. The cable rolled off the south hold-down saddle at the end of the west side span with a considerable torsional movement. The amount of damage at this point is not known. At other points superficial examination discloses no evidence of failure, but this is no proof that the cables are undamaged other than above set forth.

Suspended Structure.—In the side spans the stiffening girders have buckled beyond repair at certain points easily discernible. At these points the stringers and laterals have failed by buckling.

Approach Spans.—The approach spans were practically undamaged during the failure.

(To be continued)

Continuous Working in War Factories

By "ERICUS"

ONE might profitably give time and thought to the examination of ways and means of giving war workers necessary rest and relaxation by means other than closing a factory, and, therefore losing the output represented by the close-down time. My own experience in a new factory now employing about 3000 hands and continually expanding may be of general interest in this respect.

We started with a dozen or so semi-skilled hands. For a few weeks (summer, 1940) there were, of course, no days off for anyone, but as soon as local labour began to be recruited the management decided all employees must be given a rest day regularly. Our first effort was to give one day off in eight. This was done by dividing the employees into eight groups, each designated by a code letter A, B or C, &c. One group was always resting and seven groups working. The day off coming every eighth day, it was a different day of the week each time until the worker had had each of the seven days off. This is a very fair arrangement, as no person can complain that another has any special preference in the matter of time off. Some workers would always prefer to work Sunday, some not work Saturday, &c. &c. Workers were informed of their rest day by a notice posted by the clock, stating rest days for group A over several weeks and likewise for other groups.

After a month or two, however, the Minister of Labour decided to make an order calling for one rest day in seven. This was awkward, as we particularly wished to keep our idea of giving one worker each day of the week in turn. By persevering we managed to persuade the Factory Inspector that one day off per week was just the same thing. This was arranged by leaving our first scheme unaltered excepting when it was a worker's turn to rest on Saturday he had to take the adjacent Sunday as well. Each of these days was in a different pay week, so his pay was six days in each case as usual. He had the advantage of a long week-end to look forward to, every seven weeks. The only drawback was that two-eighths of the workpeople were then resting on Sunday instead of one-eighth or, from an output point of view, the Sunday production might be expected to be only six-sevenths of that of any other day. As we were then working ten-hour shifts daily, this amendment to our original scheme also brought us into line with the order forbidding the working of female operators for more than sixty hours per week.

The next step was considerably more forbidding. As soon as a pilot plant was running throughout the factory the management decided that production should commence in earnest, and this meant starting a night shift with all its change-over complications. The management laid down that the factory must run continuously. The question of two long shifts or three short shifts was examined carefully. The three-shift system was eventually ruled out. It was considered that owing to the nature of the work done and the fact that shops would be rather thickly populated, that two ten-hour shifts per day would be the best system. This gives the machines an hour's rest four times in twenty-four hours during which oiling and greasing, maintenance or tool setting may be done. Equally, it empties the shops of personnel just as frequently and gives an opportunity for thorough ventilation. Also, the total number of workpeople to be found and trained is less than with three shifts and transport problems are eased.

Other guiding factors were :—

(*a*) Hours per week to be kept below sixty.
(*b*) Variations in hours per week to be kept as small as possible.
(*c*) Hours paid for (including overtime allowances in hours) to vary as little as may be practicable.
(*d*) Rest days to be at least one in seven.
(*e*) Any other Ministry requirements to be met to the satisfaction of the Factory Inspector.

Eventually we developed a system whereby all workpeople were divided into twenty-seven different groups. Every group did a slightly different change over to every other group, but at the end of twenty-seven weeks every worker had had every possible change over in turn and had had every possible rest day.

Fig. 1 is a chart showing all rest shifts and work shifts in proper sequence for one worker for twenty-seven weeks. All workers complete this same cycle, but at any given moment each group is at a different point in the sequence. This is shown in Fig. 2, which indicates the "work" and "rest" of all groups for a period of approximately seven weeks. This chart was the one issued to foremen, booking and wages clerks, &c. By means of it newcomers were allocated to the various groups to keep them balanced and anyone interested could read off whether a worker (of known group number) was working, resting or changing over at a particular time. The chart comprised one blue print blank for fifty-four days, after which each sequence was repeated in every respect excepting that the date and day of the week was different. These two particulars were therefore printed in on the blank with an alkali solution at the beginning of each fifty-four-day period.

It will be seen that this system gives twelve of the twenty-seven groups always working on any day shift, eleven groups always working on any night shift, and four groups always out for rest or change over. In most concerns it is an advantage to have a small percentage of additional staff during the daytime, when many little jobs have to be cleared up on the advice of senior supervisors,

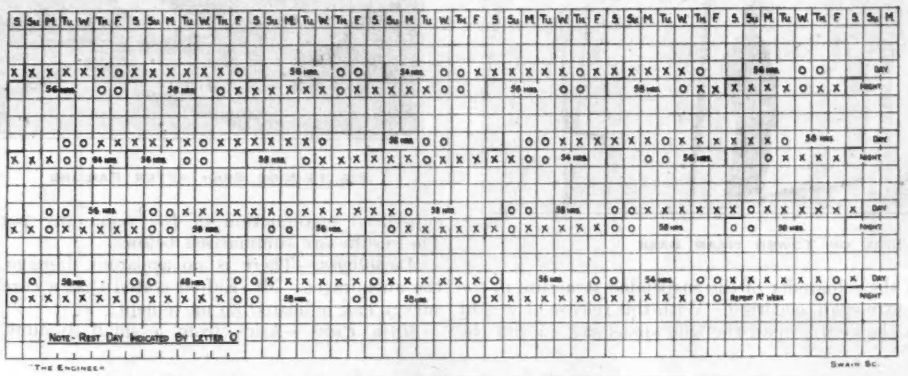


FIG. 1—REST SHIFTS AND WORK SHIFTS FOR ONE WORKER FOR 27 WEEKS

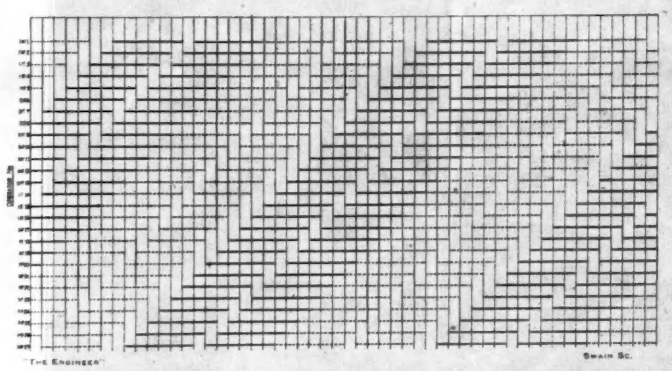


FIG. 2—WORK AND REST PERIODS OF GROUPS: DAY AND NIGHT SHIFTS

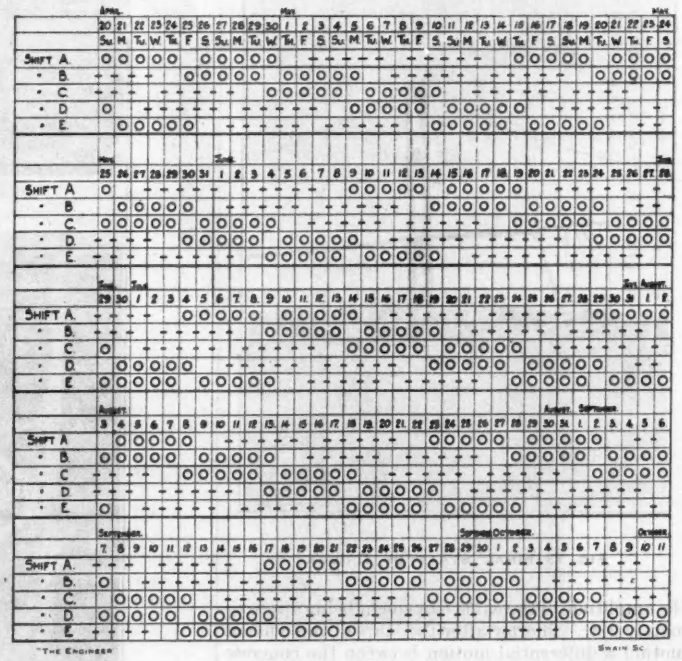


FIG. 3—WORK CHART OF "FIVE SHIFT" SYSTEM: DAY AND NIGHT SHIFTS

who are probably not available at night. Another advantage of this system is that rest and change-over shifts occur continuously and therefore only a small percentage of workers drop out or start a new series of working shifts at any one time. This makes the supervisor's job of rearranging his labour very little on each shift.

This scheme was eventually dropped in favour of one which had the advantage of appearing much less complicated to foremen and wages clerks. The new scheme cut the number of groups from twenty-seven to five and gave one an opportunity of memorising the position of the various groups at any one time. It has some drawbacks in that working hours per pay week vary more widely, as do also the pay hours (inclusive of overtime allowance in hours). Also, about five times a week half the workers on a shift come in after rest or change over and this is liable to give rise to difficulties in allocating jobs or machines to them and getting them working quickly. In practice these difficulties have not proved insurmountable, however, and the factory in question is now running quite happily on this system.

In detail the system is that all workers are split up into five groups, each known by a code letter A, B, C, D and E. Of these groups two are always at work, two are sleeping for the opposite shift, whilst one is resting or changing over. The method by which this is arranged is most easily understood by reference to the chart in Fig. 3. It will be seen that each worker works five shifts and rests one, then repeats five shifts of work, followed by one rest day and one change-over day (making two complete consecutive days away from work). The worker then comes back on the opposite shift. This sequence is repeated indefinitely. The various groups must overlap to the same extent as indicated on the chart (Fig. 3) and so long as this is done there is always a full complement of workers at the factory. In twenty-five weeks every operator has had every possible rest day or change-over period, so there should be no question of some people having advantage over others. The average working week is a little over fifty-four hours, which cannot be considered excessive in wartime. Likewise, the breaks of (in our case) thirty-seven hours away from the factory after the first five shifts of work and forty-nine hours after the second five shifts of work must be considered reasonable and usefully spaced in these days, when some managements are still asking their workpeople to work seven days a week indefinitely.

No doubt some readers will be very interested in the total personnel necessarily carried on the books for these schemes. This is an important item in these days, when any new staff has almost invariably to be trained before being of use, but equally important is that we shall make the maximum use of the plant available in the country. Such figures for increase of workers must therefore be correlated to total factory working hours per week and also considered in relation to the possibility of conforming with the various Orders which indicate the settled policy of the Ministry of Labour relative to conditions of work.

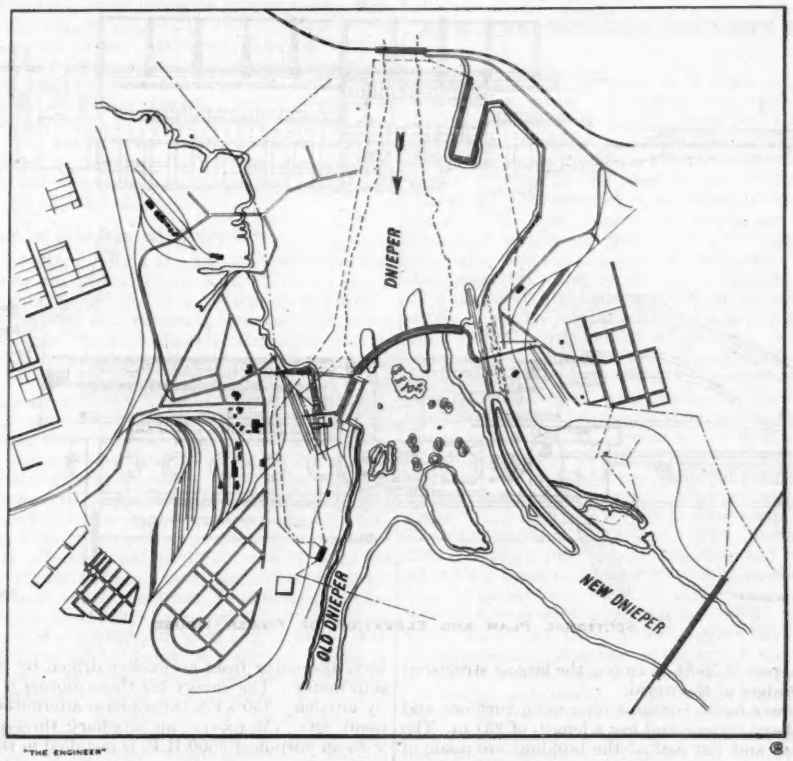
The straight two-shift system worked to its absolute limit, *i.e.*, no rest days at all and fortnightly change over results in a factory running twenty-seven out of twenty-eight shifts, or a possible factory utilisation of 96 per cent.; but I do not propose to make any comparison with this, as the hours of work and lack of rest days are contrary to all Ministry Orders and any management trying to work by such means is obviously going to lose so much by unregulated absenteeism that it is likely to arrive at a state of chaos. The very least amount of rest allowance that can be considered is a rest day off in the middle of the fortnight, leaving the twenty-four hours change over at the end to be called a rest period. This gives us twenty-five shifts worked out of twenty-eight, or a possible factory utilisation of 89 per cent. I am quite sure that this still does not comply with the spirit of the Ministry's policy, and I am also sure that such a system will still result in very considerable unregulated absenteeism. The only satisfactory comparison which can be made between two straight shifts and our "five-shift" system is when a rest day is allowed each week in addition to the change over twenty-four hours. This means twenty-three shifts worked out of twenty-eight, or a possible factory utilisation of 82 per cent. These percentages must be compared with the 100 per cent. factory utilisation possible with our "five-shift" system. To operate this it is necessary to carry 25 per cent. more personnel than is required for two straight shifts, but as we get a possible 100 per cent. utilisation as compared with 82 per cent. in the case just stated it is obvious that per unit of production we carry 125 workers per 100 units, compared with 100 workers per 82 units $= \frac{125}{100}$ and $\frac{100}{82}$, or 1·25 and 1·22.

Our labour figure per unit of production cannot therefore be appreciably improved upon whilst complying with the Ministry of Labour Orders, yet our possible factory utilisation is 100 per cent., compared with 82 per cent. on a comparable straight-shift system, which gives our factory 22 per cent. more output by using our "five-shift" system. Surely in times like these we can afford to employ 25 per cent. more personnel if as a result our output will be 22 per cent. greater and our workpeople will have a reasonable working week with reasonable rest and relaxation.

I have not mentioned the methods of giving rest days put forward by the Minister of Labour, as these have no doubt been widely studied and put into use where applicable. Neither have I gone into details of the many little schemes necessary to cover small sections of staff, such as supervisors, A.R.P. personnel, ambulance room nurses, fire service, &c., which have to be dealt with individually, but these are not at all important compared with the main personnel which is going to directly govern the output of one's factory.

The Dnieper Dam and Power Station

THE River Dnieper constitutes one of South Russia's most important waterways, as it is navigable for ships and barges over 1900 kiloms. of its total length. The navigable part falls into two main lengths, one between Smolensk and Dnepropetovsk, about 1550 kiloms. long, and the other between Zaporozhe and Kherson, a distance of about 350 kiloms. Between these sections of the river there were nine rapids and twenty-five smaller waterfalls, which made navigation impossible over a distance of about 60 kiloms. For many years schemes for the utilisation of the river for power production were debated, and ultimately plans prepared by Professor J. G. Alexandrowsk, in collaboration with Colonel Cooper, a leading American engineer, were adopted. The scheme comprises a dam with locks, and various auxiliary plants, and one of the world's largest hydro-electric power stations, having a designed output of 560,000 kW.



PLAN OF THE DNIEPER DAM WORKS

The site of the dam is about 10 kiloms. below the last rapid. The available water fluctuates between 300 cubic metres per second, with a useful head of 38·75 m. at minimum low water, and 21,795 cubic metres per second, with a useful head of 26·75 m. at maximum high water. On the basis of these figures the normal output of the power plant was fixed at 810,000 water H.P., the maximum output corresponding to 2225 cubic metres per second of water being 927,000 H.P. Owing to these large variations the power plant can be fully utilised for seventy-five days in the year only, but the normal output is brought up to between 2500 and 4400 million units per year by the water stored in a small reservoir above the dam containing about 3000 million cubic metres. It was planned to erect another larger reservoir containing some 650,000 million cubic feet near the town of Kremenshug.

The energy produced by the power plant is absorbed by large steel and aluminium works in the neighbourhood, by the iron ore mines of Krivoyrog, by the manganese mines of Nikopol, and by various industries in the towns of Dnjepropetrosk and Kamensk, while any surplus energy is transmitted as far as the Donets basin.

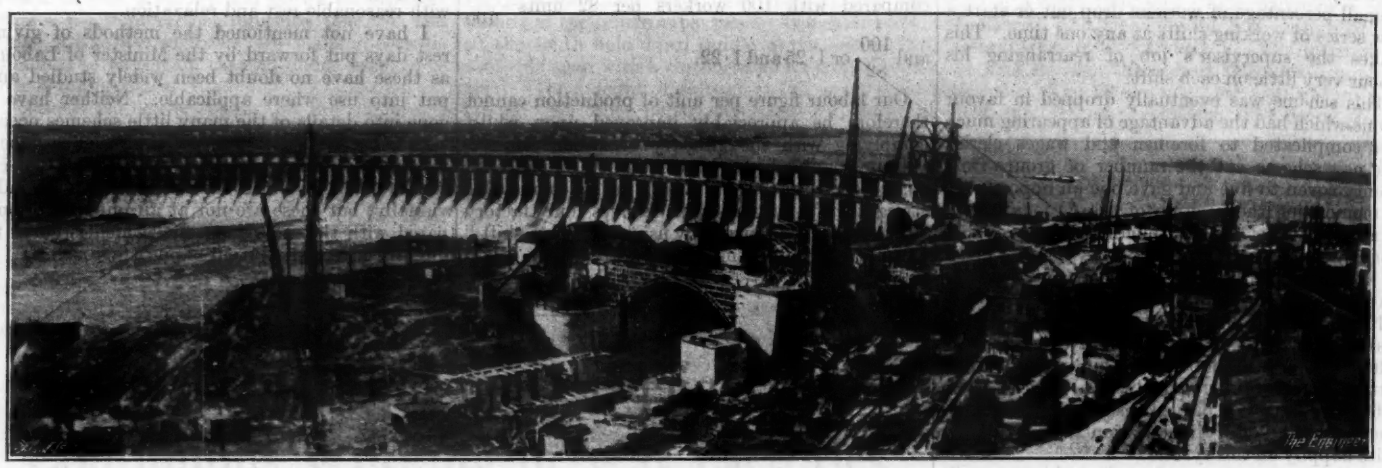
Work on the dam was started in 1927. A total of 120 million cubic feet of earth and 63 million cubic feet of rock had to be moved and 40 million cubic feet of concrete had to be filled in. Beginning with primitive man power, using peasant labour with horse-hauled cars, mechanical means on an extraordinary scale were later used, and the number of workmen employed eventually rose to 7500.

Owing to the extensive use of men and machines the first set of the power plant was ready for operation in April, 1932, *i.e.*, only five years after the beginning of the work. The mechanical installations employed on the works comprised large liquid oxygen plants for blasting purposes, huge concrete mixers, extremely large crushers, locomotive derrick cranes of 40 tons lifting power, and a large number of cranes up to 10 tons lifting power. A heat power plant with an output of 13,000 kW supplied energy for 500 motors through distribution lines 35 miles long. Moreover, steam and internal combustion engines with a total output of 10,000 H.P. were used. A settlement of 600 houses for the housing of about 10,000 workers and their families was built.

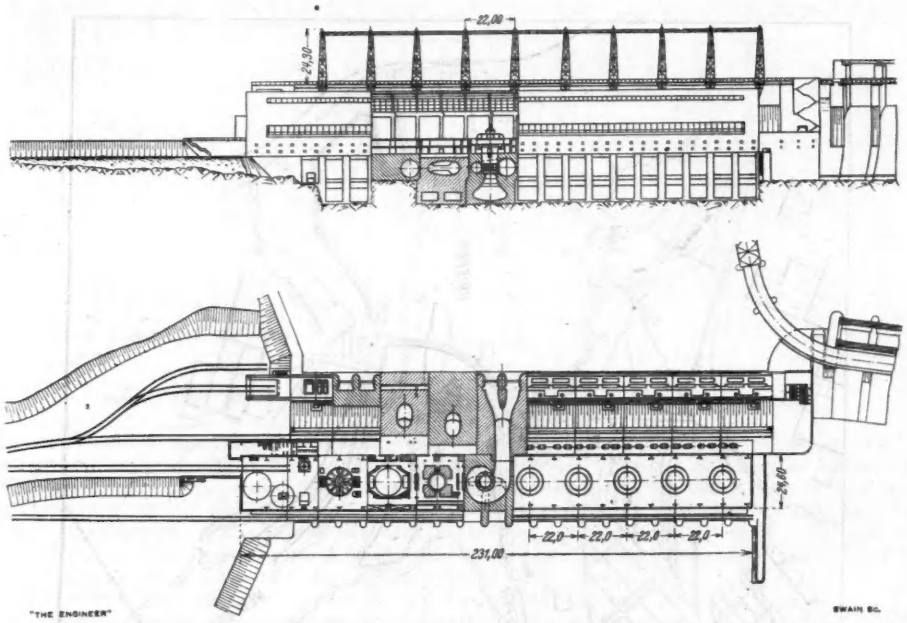
The concrete dam is of the gravity type and is curved to a radius of 600 m. Its length is 760 m., its maximum height above foundations 62 m., and its maximum width on the foundations 59·5 m. Movable weirs are arranged on the top of the dam. The overflow consists of forty-seven openings, each 13 m. wide. The openings can be closed by welded Stoney sluices, each weighing 80 tons and operated by two portal cranes of 180 tons lifting power. Three million cubic feet of concrete were employed in the construction of the dam.

For the passage of ships three locks with a total lift of 130ft., *i.e.*, 44ft. per lock, are provided. The dimensions of each of the locks are :—Length, 400ft. width, 60ft.; and depth, 12ft. The time required for

THE DNIEPER DAM, RUSSIA



the passage of a single ship amounts to 1½ hours, but is reduced to 45 minutes when a series of ships is towed. The locks are mechanically operated throughout. The towing is effected by electric capstans controlled from a tower situated on the top of the middle lock. Besides the dam and the locks a harbour with a quay about 6 miles long for an annual output of 600,000 tons, a railway line of 14 miles and two bridges have been erected. One of these bridges

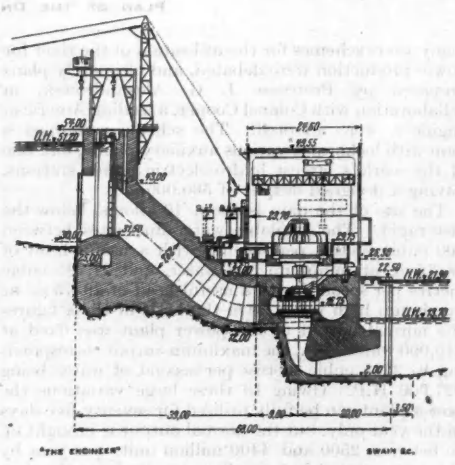


SECTIONAL PLAN AND ELEVATION OF POWER-HOUSE

having a span of 750ft. is among the largest structural arched bridges of the world.

The power-house contains nine main turbines and one auxiliary turbine and has a length of 231 m. The lower part and the roof of the building are made of concrete, whereas the walls are constructed as an iron framework covered with slabs of a light material similar to pumice. All the turbines, which were supplied by the Newport News Shipbuilding and Dry Dock Company, of Newport, U.S.A., are vertical, single-flow Francis spiral turbines with an elbow draught tube. They are designed for a rated output of 80,000–103,000 H.P. each at a speed of 88·25 r.p.m., the average effective head available being 124ft. and the water capacity of each turbine being 175 to 247 cubic metre per second. The point of highest efficiency (92·1 per cent.) corresponds to 89,000 H.P. The inlet has a diameter of 4·63 m., the outlet of about 5·84 m. The spiral is riveted and set in concrete. It has a diameter of 20·3 m. and weighs 800 tons. The turbines are equipped with automatic Woodward regulators.

The characteristic data of the alternators coupled with the turbines are as follows:—Output, 77,500 kVA at unity power factor; 62,000 kW at 0·8 power factor, 50 cycles; generated voltage, 13,800; speed, 88·5 r.p.m.; efficiency, 98·4 at unity power factor, or 97·8 at power factor 8. The weight of the rotor is 438 tons, the total weight of the alternator 780 tons. The stator has a diameter of 12·6 m., the diameter of the rotor being 10·4 m. The whole set, turbine plus alternator, has two thrust bearings and one guide bearing above the rotor. The total weight of the rotating parts plus the hydraulic thrust on the runner amounts to 1,850,000 lb. and is carried by the thrust spring bearings. The alternators are among the largest of their kind ever built. The Boulder dam alternators, *e.g.*, have an output of 82,500 kVA and each alternator from an exciter driven by an induction motor. The energy for these motors is supplied by auxiliary 750-kVA three-phase alternators on the main sets. Moreover, an auxiliary three-phase set with an output of 3500 H.P. is installed in the power-



SECTION THROUGH POWER-HOUSE

house. The terminal voltage of the alternator is stepped up to 161,000 volts by nine banks of 26,000 single-phase transformers, which are placed outside the power-house. The transformers have forced oil cooling and are of the non-resonating type, the winding being protected against lightning and switching surges by electrostatic shielding. The outdoor type switchgear is situated on the bank of the intake basin. The alternators are direct connected to the transformers, so that circuit breakers are provided on the 161,000-volt side only. These circuit breakers are of the oil-blast type with explosion chambers and have a rupturing capacity of 2,500,000 kVA. The outgoing 161,000-volt overhead lines have a total length of 550 miles.

South African Engineering Notes

(By our South African Correspondent)

CAPE TOWN, April 21st.

Shipbuilding in South Africa

IN the House of Assembly during March the Minister of Commerce and Industries dealt with a suggestion made by Mr. Acutt that a shipbuilding industry be established in the Union, and said that a subsidy had been suggested. If that meant a subsidy on tonnage produced, he must turn it down. Subsidies did no real good to industry and often a great deal of harm to the country. He was partly in agreement with Mr. Acutt on the advantages which such an industry would confer on the country. There were other ways of helping such an industry than by subsidy. It had been suggested that the Government might provide the site and waterfront for the establishment of a shipbuilding yard and with that suggestion he agreed. Another form of help was that given to most of South Africa's secondary industries. In the initial stages of a shipbuilding industry it would be necessary to import a large number of raw materials and other commodities, and a rebate of duties on such articles might be made. Labour for the shipbuilding trade was unobtainable to-day, but after the war a great many of those returning would be skilled workers and would be able to form the nucleus of a labour force for shipbuilding work. These workers would be the right type to instruct South Africa's youth in shipbuilding. He did not object to the suggestion that certain South African youths should go overseas for training, but thought there would be facilities in South Africa for this.

The Minister said he did not want it to be thought that he was unsympathetic to Mr. Acutt's suggestion. He believed in it. Mr. Acutt had said a big firm was prepared to start up a shipbuilding industry, and he should ask that firm to frame a scheme which, if he wished, he could send to the Minister, and he would send it to the Industrial Development Corporation for consideration. If in the scheme any form of Government help was required he (the Minister) would take up with the Government and see to what extent they were prepared in the national interest to help that industry. Personally, he believed that in the course of a few years it should be quite possible to establish such a reasonably sound industry in South Africa.

The Minister also said that as far as an aeroplane manufacturing industry in the Union was concerned, he would suggest that Mr. Acutt follow the procedure he had recommended in respect of the shipbuilding suggestion—get a black and white proposal from some established aeroplane manufacturing firm. He doubted, however, whether aeroplane engines could be produced in the Union.

Quicker Loading at Durban

On March 18th the new £55,000 additions to the coaling appliances at the Bluff, Durban, were opened by Mr. E. X. Brand, System Manager of Railways (Natal), in the presence of prominent Durban business men. These additions, which took four months to install, will enable the plant to load ships at 600 tons an hour, or twice the present speed, and to eliminate

delays to shipping and congestion in the harbour. At the same time they will facilitate the loading of iron ore, manganese, and other minerals now in demand overseas. The loading of the fourteen overhead bins which have a capacity of 14,000 tons will now take ten instead of forty hours.

Proposed New Dry Dock at Table Bay

The Union Government has asked the Dutch contractors who are building Table Bay's new harbour, first, whether they will be in a position to reclaim the site for the proposed dry dock when their present contract ends, and secondly, submit a provisional tender for the work. It is not quite certain whether the contractors will be able to undertake the additional contract when the present work is completed towards the end of this year owing to the difficulties experienced in obtaining spares, material for repairs and skilled labour to execute the repairs to their craft due to weather conditions. The Table Bay Harbour Advisory Board is understood to have considered a plan for the proposed graving dock submitted by the Table Bay Harbour Engineer, Mr. G. R. Lankester. It is expected that a further plan will be submitted to the Board shortly. A foreshore planning scheme has been drawn up jointly by Mr. F. Longstreet Thompson and Professor L. W. Thornton White for the guidance of the Minister of Railways and Harbours, who has asked for the City Council's views upon it.

Factory for Farm Implements

The establishment of an agricultural implements industry in South Africa has been attempted several times without success, but at last the stage has been reached when a factory has been set up in Vereeniging, Transvaal, and by the end of this month, it is stated, it will have reached full production. The plant was purchased in America and supervised by an American expert. Co-operation was established with a big American firm which will now supply implements and parts at present not manufactured here and will also give assistance and technical advice. The Government has been promised that the prices will be the same as non-dumping prices before the war, which will be a big saving for farmers. It is proposed to make flat and angle ploughshares, single furrow ploughs, cultivators, harrows, landsides, moulds and ditchers this year, and soon the works will be able to produce double-furrow ploughs and other implements.

Cellulose Pulp for Rayon

A new industry which might be started in South Africa has been suggested by Dr. J. P. van Zyl, chief of the division of chemical services. This is the manufacture of cellulose pulp for rayon. It has already been proved, he said, that bagasse is suitable for this purpose and the sugar industry here is favourably situated for such an enterprise in that it is possible to obtain coal at a reasonable cost and thus release bagasse for processing.

Increases in S.A. Mining Costs

In a little over two years the cost of gold production per fine ounce in the Union has increased by 10s. as a result of the increased weight of taxation, the cost of additional benefits to workers and the higher costs of supplies under war conditions. The working cost per ounce factor first appeared in the Chamber of Mines statistics for January, 1939, when the return was 91s. 3d. For the year the average was 91s. 8d. For 1940 it rose to 98s. 6d. In January of this year the figure reached 100s., and for February, according to the returns now available, it was 101s. 3d., despite the fact that the average recovery per ton milled showed a small increase on the January figure, being 4·201 dwt., against 4·164 dwt. Working costs per ton milled in February were 21s. 3d., an increase of 5d. on the January figure. For January, 1939, the figure was 19s. 3d. and the average for the year was 19s. 5d. For 1940 the average was 20s. 8d.

Rhodesian Costs Also Rise

An index compiled by the Southern Rhodesia Government Statistical Bureau indicates that since the outbreak of war the rise in the prices of mine stores in Southern Rhodesia has been 15 per cent. In the case of the larger mines the advance has been 13 per cent., the medium mines are up 17 per cent., and the small mines 18 per cent. more for their requirements. Auction sales of small mines with their plants are becoming ominously more frequent, though the position has been relieved to some extent by the Government importing supplies of mercury and controlling those supplies, and also the drill steel requirements of the industry.

Exhibition War Train

A war train, including three special armoured trucks, is at the time of writing on a six weeks' tour of nearly fifty towns in every province of the Union. The war train is exhibiting the artillery and other weapons, armoured fighting vehicles, ammunition, equipment, uniforms and food supplies, which the Union's war supplies organisation is now turning out in great quantities. One of the primary objects of the tour is to enable the country to see for itself the range of war materials produced by South African home front workers in South African factories from South African resources. The tour will emphasise that this is a war which is likely to be won or lost by the home front fighters in the machine shops and factories.

Port Elizabeth Water Shortage

Port Elizabeth's shortage of water, owing to its inability to obtain pipes to complete its new water scheme, has resulted in the Municipal Council of that city agreeing to explore the possibility of linking the city's water supply system with Uitenhage's reservoir at Groendal, the object being to obtain 1,000,000 gallons a day to supplement the city's present supply till the new Kromme River scheme can be completed and brought into operation. It is estimated that the connection and pumping will cost the city a capital outlay of £70,000. Meantime the city's new water scheme, to cost about £1,250,000, of which half has been expended, is indefinitely held up, war having stopped delivery of pipes.

Higher Railway Costs

Additional railways and harbour estimates of expenditure for the year ended March 31st, 1941, totalling £1,404,271 on revenue account and £5000 on capital and betterment account, were tabled in the Union Parliament during March. The additional amounts are distributed among various branches of the service, the largest, £586,208, for miscellaneous expenditure, including the payment of cost-of-living allowances, the difference between civil and military pay of staff on active service, a proportion of the expenses of the Civil Re-employment Board and of the Essential Services Protection Corps. Engine mileage figures are expected to exceed the estimate by 5·65 per cent., necessitating additional expenditure, particularly for running staff wages and fuel. The increase in expenditure for running expenses is equivalent to only 1·95 per cent. Road motor services also cost more owing to new services, extensions of existing services, and increased costs of petrol, oil, tyres and tubes. Increased shipping requirements account for an additional amount for harbour expenses. An additional amount of £353,357 is required for steamship working, mainly because of the cost of running chartered and requisitioned vessels. The excess is covered by increased revenue. Only £5000 is required for railway construction, against which the savings on capital and betterment account are £2,583,842.

Effect of Sale Tax on Motor-Cars

In March last a sale tax on motor-cars was imposed by the Union Parliament. The tax is 1d. per pound on the weight of a car and its imposition caused a big rush to buy cars before April 1st, when it became law. From all Union centres came reports from dealers that nearly all of them had been sold out of new cars by March 31st, and one dealer said he was living a virtually "hand-to-mouth" existence, delivering new cars as fast as they came in right up to the last minute. It would appear that the demand for new cars was phenomenal during all March and was not due only to the news of the sales tax, but people seemed to have realised that prices are bound to go up and had made up their minds to buy at once. It is a fact that deliveries from overseas were, and are, slackening off, and that supplies from Britain are now very difficult to obtain, since English car factories have switched over to munitions. In 1940 the importation of motor-cars, whole or in parts, decreased from 37,640, valued at £5,860,000, to 23,052, at £4,070,000. For 1941 there will probably be a further decline in cars imported, but considerably less than for 1940. The importation of motor spirit also declined in 1940—as a natural corollary—from 181,400,000 to 172,070,000 gallons, the decrease for the second half of the year being from 89,900,000 to 68,300,000 gallons, which reflects a decline of private consumption by over 20 per cent.

DRINKING WATER STANDARDS*

A FIRST draft of suggested modifications of the U.S. Standards for Drinking Water Quality has been prepared by the sub-committee and transmitted to the full committee membership for review and comment. Some of the changes in statement of the standards that are under consideration are as follows:

Improvements in bacteriological technique, particularly for determination of the coliform group and the interpretation of the results have indicated the advisability of modifying the statement of the bacterial part of the standard to conform more nearly with accepted practices. No material increase in the stringency of the standard is contemplated, but certain features of the bacteriological requirements are under consideration. One of these concerns the examination of larger portions than the 10-millilitre size now specified. Where the coliform density is approximately one per 100 millilitre of sample (the upper limit permitted by the present standard), it can be shown readily that the examination of 10-ml. portions does not permit the detection of the coliform group by the dilution method in this range. By increasing the size of portion examined (to 100 ml.) this difficulty is overcome and the result may indicate an approach to the limiting value permitted by the standard and consequently permit the inauguration of remedial measures before the permissible bacterial limit is exceeded.

To avoid the occurrence of periodic breaks in the bacterial quality of approved supplies (which lapses now are possible because results are averaged over long periods) it is suggested that the period for averages be limited to one month. In other words, that for approval, any water supply involved should meet both requirements of the standard during any one month. However, when a result is indicative of significant pollution, it is suggested that at least daily samples be examined until satisfactory bacterial quality is again attained.

Due attention should be given to the water quality as delivered to the consumer, and it is proposed, therefore, that a specified minimum number of samples receive routine examination from various points in the distribution system, this number to be governed by the average daily volume of water delivered.

Some changes have been suggested in that part of the standard concerned with "physical and chemical characteristics" in accordance with new facts that have been developed since 1925. These modifications relate to certain toxic metals and their salts which may occur in water and to other objectionable substances in waters used for drinking and culinary purposes. Among the objectionable metals being considered for the first time are boron, selenium and fluoride. The present allowable limits of copper and of zinc might well be raised, and the same is true of caustic alkalinity and of the carbonates of sodium and potassium in over-treated waters.

* From American Waterworks Association Meeting, June 22nd to 26th.

AMERICAN CELLULAR CONCRETE BRIDGE

AN interesting example of a concrete bridge of the cellular girder or hollow box type of construction is one of 120ft. clear span over a stream in California. This type of construction was adopted in order to secure a minimum depth, so that the surface would conform to the level of the streets while a maximum headroom for flood waters would be provided. The span consists of eleven girders built integrally with a top and bottom slab, and spaced 6ft. 4½in. between centres. These girders are 33in. deep and 14in. thick at the centre of span, tapering to a depth of 51in. and a thickness of 24in. at the abutments. The top slab has a uniform thickness of 7in., while the bottom slab ranges from 6in. at mid-span to 16in. at the abutment. These slab thicknesses are included in the depths of the girders and transverse partitions 30ft. apart divide the hollow spaces into closed cells. A special and curious feature of the design is that the abutments act as counterweights exerting an end moment into the girders, so that the normal dead load and live load moments are only about 8,500,000 foot-pounds, whereas without this counterbalancing they would be four times as great. The total width of the bridge is 62ft., including two 25ft. roadways, with 4ft. dividing strip and two walks 4ft. wide. Dead load was reduced both by the cellular type of construction and the use of concrete made with a light-weight aggregate of 110 lb. per cubic foot. Cars and the smaller motor lorries cause no appreciable vibration, but under the passage of heavy lorries the deflection and vibration are distinctly noticeable. However, measurements show that the actual vertical movement is slight and does not exceed the calculated amount. The maximum movement recorded at mid-span was 0·010ft. under a heavy oil tank lorry. In tests of the vibrations the maximum positive amplitude was about 0·002ft., with a frequency of three cycles per second for a period of seventeen seconds.

TO CHEAPEN MERCURY.—American metallurgists are trying to cheapen the production of mercury from low-grade ores. The average mercury content of United States ores is round about 0·35 per cent., and although their exploitation is profitable under current prices for the Spanish-Italian metal, lower world prices for mercury have in the past invariably checked the use of an ore from the Mirabel mine in California, the gangue being largely serpentine and the head assay about 0·33 per cent. quicksilver, cinnabar being the only sulphide mineral present. Another ore being investigated comes from the Yellow Pine district in Idaho. Here an average head assay is about 0·90 per cent. quicksilver.

AUSTRALIAN PERMANENT WAY IMPROVEMENTS.—During the financial year ended June 30th, 1940, some 12 miles of main line in the Adelaide Division were relaid with 94 lb. rails, and about 5 miles in the Peterborough Division were relaid with 60-lb. material. On secondary lines in the former division a total of 2½ miles of curves was relaid with 80-lb. metals, and on the Salisbury-Pirie section 12¼ miles of line were improved by the widening of formation and ballast widths, and the welding of the rails into long lengths. In the Tailem Bend area of the Murray Bridge Division about 33 miles of track were ballasted, 35,000 tons of material being used. Rails in this area were also reconditioned and replaced where necessary. The track was strengthened on other divisions by increasing the numbers of sleepers and reconditioning the rails.

The Engineer

SEPTEMBER 5, 1941

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THE CONTRA-ROTATION PROPELLER

THE many ingenious inventors who for years have advocated the use of jet propulsion for aircraft hardly seem to realise that this is really a type of propulsion which in a somewhat different form is already in almost universal service. The ordinary airscrew is really a jet-producing mechanism. The inventors of whom we are thinking have usually proposed the alternative of ejecting burnt gases from an internal combustion turbine of some kind. Their method, if and when it comes, will no doubt have at least the merit of producing a jet free from rotation, whereas the slip stream from the ordinary airscrew contains a marked element of rotation, not only useless in itself, but a serious nuisance, because it produces a rolling moment in single engine aircraft by its unsymmetrical impact on the tail surfaces. This latter effect is further complicated by the fact that the torque reaction from the airscrew drive also produces a rolling moment of its own. Both these effects can be balanced out by arranging for suitable aerodynamic couples to be obtained from the lifting surfaces, but it is obvious that any such nice balance is upset when conditions change, as, for instance, when engine speed is altered. Since even a small angle of roll tends to produce a proportionate amount of yaw, it will be seen that really accurate flying must be influenced adversely, and during fighting manœuvres, especially at the moment of opening fire, this may be troublesome. It is a fact, too, that any angular motion about one of the principal axes of the aircraft is, by reason of the gyroscopic property of the rotating airscrew, at once translated into motion about one of the other axes. It is here that the new contra-propeller—or "contra-rotation airscrew," as the makers call it—comes in so usefully. Its slip stream has no rotation whatever and although it would seem that in any such mechanism the engine torque must still remain to be balanced, there is certainly achieved a marked and welcome simplification of the whole problem.

The use of twin airscrews rotating on the same axis, but in opposite directions, is not in itself new. It was used many years ago in the Italian racing seaplanes, though in that case each airscrew was driven directly by a separate engine, so giving, in principle at any rate, a balance of torque reaction as well as freedom from rotation of the slip stream. In our own Schneider Trophy seaplanes we did not adopt this expedient and owing to the then unusual power of the engines for so small a machine much trouble was caused in practice by the tendency of one of the floats to submerge when taking off from the sea, a tendency successfully met in the end by the ingenious plan of using part of the fuel as a means of making one float heavier than the other. The information now liberated shows that the Rotol Airscrew firm has built and successfully tested on the bench a pair of oppositely rotating constant-speed three-bladed airscrews capable of being driven by a single engine and weighing, it is stated, only some 10 per cent. more than a single airscrew capable of taking the same power. Two other firms, Fairey and De Havilland, are also making contra-running airscrews. Such a pair would naturally have a smaller overall diameter than a single one, and this is a further advantage, since it assists the designer as regards ground clearance and the placing of the guns in the wings. We do not doubt that the contra-rotating propeller will prove as successful in flight as it is reported to have been on its bench tests. The parent firms have a repute which ensures that the highest skill in design and construction will have been used in the mechanism. No doubt a pointer to a possible lay-out was given by the often ventilated, and now commonly used, scheme of having a fixed cannon fitted inside the airscrew hub and firing through it. Such an anchorage would suit the differential mechanism which one can picture as having to be employed to give the opposite and equal rates of rotation that are required. The value of the new scheme relates chiefly to single-engined aircraft, since when either two or four engines are used one can, if one wishes, provide for opposite directions of rotation, though at the price of the non-interchangeability of the right and left-handed engines and consequent increase in the store of spare parts that need to be maintained.

In this new airscrew combination there is more gained than we have so far mentioned by having six working blades instead of three. Not merely does it have the advantage cited of reducing the disc diameter, but there is less tendency for designers to yield to the temptation of raising the tip speed to a level so close to the velocity of sound as to lower the efficiency of the airscrew. On balance the slight extra weight involved by the use of the contra-rotating propeller may well prove to be a price worth paying. In this connection it is worth recalling the experiments of General Rota on contra-rotating ship propellers and particularly his discovery that there was a marked improvement in propeller efficiency when the propellers were of different diameters. Since it would be unsafe to conclude that what was true in water would be true in air, it would be of great interest to know if this line of research has been pursued.

Engineers, the Institutions and the Government

MODERN civilisation is built upon the work of scientists and engineers. The world owes to them its means of rapid transport, its methods of instantaneous communication, its uses of new building materials, the development of great formerly unproductive areas into granaries, and the provision for all of heat, light, power and so great a host of labour-saving devices that, as compared with the not very distant past, all classes of the populations, at least of Europe and America, could now be regarded as "leisured." In peacetime so great is the abundance of the earth's produce made available by engineering methods that no reason seems now to exist why there should still be malnutrition or the want of necessities. Engineers, having produced this abundance, have heretofore left it to others to reap where they have sown. But the confused unsatisfactory march of events "between the wars" led many engineers and scientists to consider whether it might not be for the good of all were they to take a greater share in determining what use was made of the things their brains and hands were making available, and the outbreak of the present struggle, in which the work of engineers is of predominant and truly vital importance, has served to emphasise the lack of their influence on national organisation and national affairs. Their dissatisfaction is demonstrated by the growing desire of the major institutions to act in concert to advise the Government on engineering matters and the latent impatience at the lack of effectiveness of the Engineering Joint Council, set up some years ago, which could achieve just such an object, but is so entangled in rules designed to safeguard the rights of individual institutions that it can now effect little or nothing.

The impression that engineers exert too small an influence on the national life is not confined only to this country. In Germany, France and America associations representing all engineers have existed for some time and have exercised some influence in national affairs. Yet it remains a fact that engineers as a whole lack social consciousness. In a speech reprinted in this issue, Professor Christie, of the John Hopkins University of America, makes the plea that engineering students should be trained to understand the political organisation of their country, its governmental methods, the history of its institutions and the trends of its social development. Only if so trained, the Professor implies, are engineers likely to gain influence over the manner of use of technical developments that are due to the application of their skill. But the training of an engineer is long and arduous. The student must spend at least three years at college and a further three as a mere apprentice before he can regard himself as even elementarily equipped to play his part in engineering. Where then is the time to be found for the study of topics which are of no direct use to him in his chosen profession? And even if, as suggested by Professor Christie, the college course is restricted almost wholly to the study only of fundamentals, the descriptive and "application" courses are eliminated, and time is thus saved for introducing another subject, is it really desirable or necessary that to the engineering courses there should be added others on political economy and history? It may be true that if engineers are to take that part in government that their importance to the community merits they must be prepared to give up time to discovering something about the history and traditions of their country and to learning what are its methods of government and how its economy operates and is controlled. But the majority of engineers are, we think, likely to feel that it is not the job of each separate individual to exercise any more influence than is obtainable through the polling booth.

Engineers no more than any other section of society wish to gain control of the organisation of the country. But they are conscious that their training has equipped them with a method of precise scientific thought that finds the half-truths and slogans that make up the "planks" of a party platform unacceptable and they do wish to be able to exercise some logical influence over the use that is made of the products of their hands and brains, and to direct it into more beneficent channels than heretofore. To achieve that purpose engineers must look, we think, to their technical institutions, and to carry out their desires the institutions will need so to combine together that governments will find their advice indispensable and be unable to neglect it. Already there are signs that under the

stress of wartime necessity this re-orientation of institution and of Government policy is beginning to come about. The Institutions of Civil, Mechanical and Electrical Engineers have for some time co-operated willingly together in their dealings with the Government, and they are also studying the possibility of collaborating to set up joint committees to study post-war problems now and to give advice upon them when peace returns. The Government for its part has so far recognised the important part that engineering can play, at least in war, as to set up an Advisory Committee of Engineers. When the war is over we confidently hope that the trend thus now clearly visible will be maintained. For as engineering is a constructive science, abhorrent of such destruction as war, pestilence or other calamity produces, it can scarcely be doubted that the influence of engineers on post-war events would be other than beneficent to all the peoples of the world.

Civil Airport Development in the United States

No. III

(*Continued from page 132, August 29th*)

SOIL characteristics of a proposed airport site are of high importance, particularly as to load-bearing capacity and drainage. With such favourable conditions as a deep-water table or ground-water level and a permeable and non-erosive soil the minimum of artificial drainage is required, and usually it is necessary only to provide for the removal and disposal of surface run-off from paved areas of runways, taxiways and aprons. Even if an alternative site may be drained at reasonable cost, the naturally drained site is likely to be preferable, since drainage systems usually involve continual expense for maintenance. This drained site will also relieve the airport of large expense for a storm water drainage system and the difficulties due to variable operating conditions.

A soil survey, with the assistance of borings by hand augers, will show the general character of the materials and indicate whether sub-surface drainage will be required, and whether the soil is capable of carrying the expected loads under all conditions of weather. Laboratory tests will be necessary, along the lines of modern developments in soil mechanics, and may be divided into tests for granular soils and for cohesive soils. In the former the bearing capacity is a function of internal stability, while in the latter it is a function of shearing resistance. In general, granular materials of nearly maximum density will have ample bearing capacity.

This investigation of the site will include such factors as ground water level, rainfall and run-off records, formation material for runways, and suitability of soil for runway stabilisation. The following classification of soil by fineness, taking account of the more minute chemical and physical properties, is given in the report of the Civil Aeronautics Administration, which approves the soils between sand-loam and clay-loam as best for developing a dry and firm surface :—

Gravel	Fine sand	Sandy clay	Clay loam
Sand	Very fine sand	Loam clay	Silt
Medium sand	Sand loam	Silt loam	Clay

In the use of soil as an engineering material one of the greatest difficulties lies in its susceptibility to volume changes, due mainly to variation in moisture content. Thus the capacity to absorb moisture through high capillarity results in loss of both cohesion and internal stability. This moisture variation is accompanied also by shrinkage or expansion of the material. Volumetric analysis, involving various density relations, is thus an important part of soil testing, since it leads to detection of soils unsuitable for runway formation and permits correction of the deficiencies. Soil stabilisation has been developed to eliminate excessive volume changes and to produce a permanent and highly resistant soil mass. Thus granular material added to clay may prevent excessive change in volume, and clay added to loose granular soil may provide ample adhesion. An admixture of cement may produce a more highly resistant and solidified soil structure, while a bituminous admixture may seal the soil against moisture.

Drainage is an effective means of eliminating excessive moisture changes, if this can be accomplished under field conditions, but there may be practical limitations due to high capillarity and low permeability. In general, sands are readily drainable, and clays not drainable. Intermediate silty textures are doubtful, and definite limits of their drainability have not yet been established.

Since one of the permanent features in the construction of an airport is the grading or surface sloping, it is important that a complete plan of the entire area should be made showing the finished gradients or slopes. Drainage, surfacing and landing area flood lighting are all affected by this factor. The maximum gradient permissible from an aeronautical standpoint must be considered, as excessive gradients make night landings more difficult. In general, the gradients for longitudinal and transverse landing areas and runways should not exceed 1 in 66. If the soil of a landing area is very pervious sand or gravel, permitting rapid absorption of rainfall, a level surface may be desirable. Where the collection and removal of surface water is necessary, the slopes should provide for quick run-off without being so steep as to cause erosion. A slope of 1 in 100 is considered to satisfy average requirements. Controlling factors in establishing the slopes and gradients are topography, soil and climatic conditions.

Filling low ground or depressions and building embankments may be necessary to obtain the desired surface, and such filled ground may be subject to considerable settlement, according to depth, material or method of placing. Such settlement might seriously affect the drainage system and runways. Under ordinary conditions it is satisfactory to place the material in thin layers, with water added before and during rolling. Plain or sheepsfoot rollers may be used, or compacting may be done by the tractors and hauling equipment having track type or " crawler " treads. Hydraulic filling should be adopted only after careful study of the material available, as it may require considerable time to become firm enough to serve as a landing area. To provide for slight settlement the runways may be surfaced with low-cost material temporarily, using this later as a sub-base for permanent paving.

The filled ground should be wide enough for the full 500ft. width of landing strip or field area and for minimum 10ft. shoulder outside this width, to provide for a service road and to ensure protection of marker, boundary and flood lights. Beyond this the slopes should be as flat as possible and protected against erosion by surface water by means of berms and gutters to intercept the flow and divert the water to a sub-surface drainage system, if the field has such a system.

Soil and climatic conditions in certain sections of the United States permit the growth and maintenance of a firm turf, enabling airports of light and limited traffic to handle this traffic on turf landing areas throughout the year. In each such case the kind of grass most suitable to the conditions must be determined. Traffic should be kept off until the grass has gained a good stand. Under heavier traffic turf is likely to become rutted. Mud is inevitable in wet seasons, and with it the maintenance of aeroplanes becomes more expensive, landings are more difficult and accidents more frequent.

Paved surfaces for runways are required for most airport enterprises, through combined conditions of soil, climate and traffic. Paving implies an all-year and all-weather surface that is firm, stable and even, designed to sustain the static and dynamic loads imposed in the landing and taking-off of aircraft, and free from dust or loose aggregate which might be blown or picked up by the whirling propellers. Such loose material contributes to the failure of metal propellers, usually at the tips, which may result in disturbing the balance of the engine or cause a forced landing because of excessive vibration.

Runway paving is divided into rigid and flexible types, the former being assumed as bridging any weak spots in the formation. For the latter it is assumed that the paving will be in constant bearing on the formation, and that load transmission to the formation will be practically uniform. Paving of the rigid type includes cement concrete—with or without steel reinforcement—bituminous concrete and some forms of bituminous or waterbound macadam. Flexible paving includes the numerous bituminous forms of construction, built-up penetration surfaces and soil stabilised with cement or bituminous compositions.

Paving problems for airports are similar to those for highway paving, the aim being to secure a dense, well-bonded and sealed surface to resist wear and prevent the permeation of water. But the loads on a runway are much less frequent than those on even a secondary road, so that compaction by traffic is not to be considered. For this reason any bituminous paving at an airport needs softer asphalt and richer mixtures, combined with dense aggregates, to ensure adequate density of the paving and resistance to wear, weather and climate. Furthermore, traffic is dispersed over a wide runway instead of being concentrated on a narrow surface, as on a highway. For this reason runway bituminous paving needs a higher percentage of bitumen and a bitumen of higher penetration property to prevent carbonisation and consequent ravelling.

The colour and light-reflecting qualities of the surface are also important to furnish a high degree of visibility for night landings and take-offs. In general, surface textures of light colour and having a high reflecting character are preferable. The recommended crowning for runways is 9in., 12in. and 18in. for paved widths of 100ft., 150ft. and 200ft., respectively. But where rainfall is light and impervious paving is used the minimum crowning may be 6in., 9in. and 12in.

Both static and dynamic loads are imposed upon runways and aprons by the aeroplanes. The static load, or gross weight of the aeroplane, is usually considered as distributed between the two main wheels or groups of wheels, even though part of the load may be carried by the tail wheel. For design purposes, therefore, the static load may be taken as half the gross weight. With existing aircraft this weight is about 15, 30 and 50 tons for airports of Classes 2, 3 and 4. But for conditions ten years in the future these weights may be taken as 30, 75 and 150 tons. Tyre pressures for use in paving design are from 10 lb. to 25 lb. per square inch for small airports of Class 1, 15 lb. to 50 lb. for Class 2, 30 lb. to 75 lb. for Class 3, and 50 lb. to 85 lb. for Class 4. Higher pressures are not considered probable, since aircraft would be equipped with dual or multiple wheels when their gross weight is so increased that pressure exceeding 85 lb. would be required for a single tyre.

For dynamic loads there is no agreement as to the magnitude of the loads imposed by the vertical component of descent by an aeroplane in landing. Flight tests that have been made were designed primarily to measure the stresses due to landing loads in the undercarriage and structure of the aircraft, rather than to measure the ground reaction. In these tests an accelerometer is mounted in the aircraft, as near its centre of gravity as practicable, and from its readings an estimate is made of the ground reaction. From such tests the impact factor of 2 was evolved as a theoretical design factor to be applied to the gross weight of the aeroplane.

Practical experience, however, has indicated that the employment of impact factors in runway design, to provide for dynamic loads, may be discounted if the design is adequate to support the maximum static loads anticipated. The apparent discrepancy between a factor of 2 and a negligible impact factor is due to consideration of the deflection of the tyre under the landing shock. Tests conducted by tyre manufacturers indicate that the tyre deflects by an amount which materially increases the contact area with the paving. Impact loads are of extremely short duration, since aircraft in landing have a velocity of 70 to 90 m.p.h., or 102ft. to 132ft. per second. However, there is evident need for further experimental work on the subject of impact landing loads, and particularly the distribution of these loads to the formation of the paved runway.

(*To be continued*)

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents)

FACTS ABOUT THE RIFLE

SIR,—I am not, I may say, an engineer, but I am very interested in small arms and have been all my life, and I have done a good deal of experimenting with old and new weapons, but particularly with revolvers, mostly of heavy calibre.

Mr. Weir's two articles are absolutely first-class and they have given me a lot of interesting and very valuable information, but there are one or two points that I would like to comment on.* The reason being that the two articles were practically without a flaw and, as an engineer himself, he realises that all statements should be strictly accurate and substantiated by figures; in fact, I take it that engineers do not take any notice of what other people think or what other people say; they are only interested in facts. As Mr. Weir says, "let us sift the chaff of hocus-pocus from the wheat of truth on the subject," and proceeds to give "a few of the pure wheat grains." What I have to say may be of interest to Mr. Weir; possibly he may know all about the different points I mention, but at any rate I give it to him for what it is worth.

Starting with the cartridge, he describes the difference between rim fire cartridges and centre fire cartridges. No doubt Mr. Weir knows and several other people reading his article may know, but I have been surprised how many people do not understand exactly how the cap of a cartridge is detonated; unfortunately, Mr. Weir does not make this clear. In the rim fire cartridge the detonating compound is retained between the folds of metal forming the flange of the cartridge and the firing pin of the rifle hits this flange and compresses it against the recess in the chamber of the rifle. The recess in this particular instance acts as "the anvil"; unfortunately, Mr. Weir does not mention the anvil in the centre fire cartridge and this is, of course, a vitally important point in the ignition of centre fire cartridges. The anvil is a small arrow-shaped piece of metal (brass), over which the copper cap goes, so that the point of the anvil is almost resting on the detonating compound; the consequence being that when the firing pin of the rifle hits the base of the copper cap the detonating compound is squeezed between the firing pin and the anvil, thereby creating a sure flash. Early centre fire cartridges were constructed without the anvil; in fact, they had no cap, but a plain base with no hole in it, and the detonating compound was stuck on the inside of the base of the cartridge in some manner, but they were not sure in functioning. I believe I am correct in saying that practically all forms of modern centre fire cartridges have some form of anvil.

Dealing with streamlined bullets, these are becoming more and more universal and are, in fact, to-day used by the U.S.A. in their Government issued cartridges, but they are not, as far as I know, used in the British Service rifle yet.

Referring to solid lead alloy bullets, I agree that it is not possible to use these in high-velocity rifles with anything like one turn in 10½in. in the barrel; obviously a lead alloy bullet would tend to strip or overhaul, but it might be of interest to Mr. Weir to know that extraordinary high velocities have been obtained with paper-patched lead alloy bullets fired in the U.S.A. I have not got these data by me, but there have been several experiments carried out. One odd note I can mention is that Elmer Keith, the great experimenter in the United States, fired a 0·50 Sharp's black powder breech-loading cartridge gun. This rifle weighed 16 lb. and took a 3¼in. case; the bore measured 0·525 at the breech and 0·519 at the muzzle; the rifle had six narrow deep lands and wide grooves, making one turn in the 30in. barrel minus the length of the chamber. The bullet was paper patched with hard Bond paper, two laps of 0·003 making a snug fit of 0·525. The bullet weight was 700 grains and 165 to 170 grains of F.G. black powder were used; actually the bullet in this case was about roughly 50 grains too heavy. The slow twist of this rifle probably needed all the speed that can be given to it, for the proper stabilisation of such a heavy bullet. Probably this bullet is the maximum weight that this particular twist will handle. The velocity of this rifle was rather over 1500 f.s., and it can be compared very favourably to a modern cordite big game rifle. This may be of some interest to Mr. Weir, and I believe higher velocities have been obtained with paper-patched lead alloy bullets.

Some more data with regard to zinc bullets may be of interest to Mr. Weir. A 115-grain zinc bullet in a 0·30 rifle was fired without stripping and without lubricant and obtained 3500 f.s. These zinc bullets were cast in a mould which was meant for lead alloy bullets and, of course, were very much lighter; in fact, the difference is some 60 grains lighter in casting zinc as against lead alloy in the same mould; these bullets fired very accurately and, of course, the powder charge should have been and actually was reduced.

Referring to the statement with regard to the right or left-handed twist and the number of grooves in various Service rifles, Mr. Weir states that Britain uses five grooves, Denmark and Japan six and all other nations four grooves. Britain and France are the only nations that use left-handed rifling. All I can say is that if Mr. Weir examines an Enfield 1917 U.S.A. model 0·30 rifle, or 0·300, as they are called in this country, he will find that they are five-grooved with left-handed rifling. These rifles were made for the American Government after the American Government had stopped making the Enfield pattern 14 0·303. Tremendous quantities of these rifles were turned out by the Remington Company at Eddystone and Ilion and by the Winchester Company at New Haven, and most of them were stamped with the name of the works they were manufactured at.

I was interested to read what Mr. Weir has to say about the Mannlicher-Carcano Italian Service rifle, varying in twist from one turn in 19¼ at the breech to one in 8¼ at the muzzle. I have not the faintest idea what this idea is for and cannot suggest any reason in a modern high-velocity rifle, but, of course, the idea is as old as the hills and was used on thousands of rifles and revolvers of the cap and ball percussion period round about 1850. In fact, a tremendous number of Colt cap and ball 0·44 revolvers and rifles were constructed on this principle, which was known in those days as the "gain twist." The idea was, of course, that the violent acceleration of the first explosion of the charge should not make the bullet override or strip in the rifling. It was essentially an idea for lead alloy low-velocity bullets. The idea was discontinued, but I can assure Mr. Weir, having fired these old weapons, that the accuracy was first-class and there was no sign when the bullet was recovered that the marks of the rifling were other than perfect.

Further on Mr. Weir makes a statement where he is discussing the reason for the British Service rifle having left-handed rifling and as an engineer he makes the mistake of going and asking the opinion of "died in the wool." riflemen as to whether they feel any rotational kick when firing a British Service rifle. He also asks them whether they feel a more pronounced rotational kick when firing a revolver with an extended arm, and they apparently tell Mr. Weir that they have never been able to detect any rotational kick. I can assure Mr. Weir that this is not correct; there is quite definitely a rotational kick in heavy calibre revolvers. I have probably fired more 0·455, 0·44, 0·38 and 0·41 in both modern revolvers and the old cap and ball percussion revolvers than anybody in this country, and I have noticed the rotational kick in both types and especially in the old cap and ball guns, where one is apt to get a pretty tight bullet, but I have noticed it definitely when one is tired when firing Colt, Smith and Wesson and Webley. I do not care what anyone says, I have definitely experienced pronounced rotational kick. It was demonstrated to me very forcibly when firing a Bisley 0·455 Colt, which is a single-action gun; I tied the trigger back with tape and fired this gun by the old Western method of "thumbing the hammer." Mr. Weir will appreciate that the thumb under these circumstances is not round the butt, or laid alongside as in target shooting, but is operating the hammer and a really firm hold on the butt is not possible. Under these circumstances the rotational kick, in my opinion, is quite pronounced.

Another point which Mr. Weir mentions is that the bulk of the noise heard when a rifle is fired is not due to the explosion of the charge, but is due to the splitting of the air by the bullet when it has left the muzzle. Surely this cannot be right. Mr. Weir goes on to say: "Hence the futility of trying to silence a rifle by the means of silencers fixed to the muzzles." Silencers were designed to dampen out or eliminate the explosion of the charge, which is really the thing which makes the noise; it never was intended to silence the noise of the bullet splitting the air, which after all with a modern Service rifle is only audible at a comparatively short distance, whereas the noise of the explosion of the charge is audible at a very considerable distance. High-velocity rifles have been effectively silenced without impairing the velocity much; in fact, a form of recoil eliminator tried out in the U.S.A. was found not only to reduce recoil quite considerably, but also to reduce the noise. Granted that silencers were designed for and are really effective on low-velocity weapons, but Mr. Weir makes the most ridiculous statement by explaining that they are useless on a revolver owing to the gap between the cylinder and the barrel. Silencers were never intended for revolvers. It is obvious to anyone that a great deal of the noise of the explosion escapes from the gap between the cylinder and the barrel. Silencers were always intended to be used on continuous chamber weapons, such as a rifle or an automatic pistol, and they are very effective on both of them. The bulk of the noise is undoubtedly made by the explosion of the charge and the silencer was intended to eliminate that noise; the noise of the bullet is not by any means the bulk of the noise heard when a rifle is fired, at least that is my opinion.

Under the heading of "Spin," Mr. Weir states that the fact of spinning a projectile gives it greater steadiness in flight and this seems to have been known from primitive times. This is a point which has always been very interesting to me, and Mr. Weir goes on to give a short explanation which is rather muddled about how rifling originated. The real facts of the situation, which may be unknown to Mr. Weir, are as follows:—

It is perfectly true, and it is a thing which I can never understand, that rifling was definitely in use from very early times and was also for some unknown reason dropped completely in favour of smooth-bore hand guns and long arms. Rifling did not become really universal until it was revived very forcibly by the appearance of the Kentucky rifle round about 1776.

But actually grooving of a gun barrel was originally introduced so that the bullet could be rammed down easily. In point of fact the grooves were intended to hold the carbon and muck left by the black powder explosion. These grooves in the gun barrel were at one time straight, some genius may have thought that by twisting them they would get a spin on the bullet and greater accuracy, but my belief is that they did not understand the principle of spin. When rifling was produced by the Nuremberg armourers, providing the bullet was a tight fit, the first few shots would undoubtedly be accurate, but it was found that with black powder fouling it was wellnigh impossible to force the bullet down against the twist unless the rifle was thoroughly cleared out. This led to many who used rifles using a smaller bullet to make it easier to ram home, thereby losing the effect that the rifling was intended to give, and nobody thought in those days of using a patch until the Kentucky rifle with its patched bullet came into use. Rifling was therefore deemed to be useless because it simply did not work with a loose bullet; there was too much windage and friction, so rifling completely disappeared and smooth-bore came in. It might interest Mr. Weir to know that Prince Rupert, in the Civil War, was well known to be a great expert in the use of the rifled pistol; these pistols were really breech-loaders and were used by some of the cavalry during the Civil War. They were cannon barrel pistols with barrels that unscrewed; the barrels were retained to the underside of the pistol, so that they did not get lost and the idea was that powder was poured into the chamber in front of the touch hole, the bullet seated on the cup on top of the chamber and the barrel screwed into place. This did away with all ramming and meant that the bullet was made a tight fit and this forced out a lot of the muck of the previous explosion ahead of the bullet. The consequence was that very fine accuracy was obtained, but for some reason or other these rifled pistols disappeared, but there are authentic records of Prince Rupert accepting and winning challenges for firing at and hitting weather vanes on churches, at which pastime he was known to be very expert. It has always been a most amazing state of affairs to me that rifling dropped out, especially since the principle of the spinning projectile was perfectly well known to everybody in England and the United States, as they had the perfect example of the bow and arrow, which in its way is even to-day a very deadly and first-class weapon. Every English bowman knew that it was necessary to turn the shaft of the arrow rapidly in the air, if it was to fly true, and this was done by feathering the arrow and balancing and weighting it so that the feathers turned the arrow in flight. Here you had the exaggerated form of the

* [These articles have now been reprinted as a little pamphlet.—ED., THE E.]

cylindrical bullet, which had it been used earlier in rifles instead of the spherical bullet, would have shown experimenters how much more accurate the cylindrical bullet was as against the spherical bullet.

One other point I am reminded of, in a book on rifles written in 1850, which a friend of mine has, they make great play in those days of the wonderful discovery they had made that the principle of accurate shooting for black powder rifled muzzle-loaders was that the bullet must be heavier at the nose, in other words, the centre of gravity was well forward. It is an extraordinary thing this; they actually did make bullets considerably heavier at the nose and obtained extraordinary accuracy with them.

Before closing altogether I must admit that I agree with Mr. Weir. I cannot for the life of me understand why the Service rifle bullet is given such an enormous rotational speed. I think Mr. Weir will agree with the formula of the slower the twist in a rifle barrel the higher must be the velocity, so that the bullet will attain sufficient speed to give it stability in flight. To mention one, the high-power 0·22 loads, such as the 0·22–3000 Lovell are fired in 30in. barrel rifles with about one in sixteen twists and have velocities of 3000 to 4000 f.s., compared with German and British military rifles, which have velocities of between 2400 and 2800 f.s. and twists in barrels of 25in. of 1 in 9 and 1 in 10. This seems absolutely idiotic. Is there anything in the idea that it may be to obtain greater penetration with excess rotational speed?

IAN GLENDENNING.

Newcastle-on-Tyne, August 15th.

SIR,—I have to thank Mr. Glendenning for his complimentary remarks regarding my articles; further, I think he deserves the thanks of engineers as a whole for the compliment—perhaps unwitting—which he pays them in concluding that "engineers do not take any notice of what other people think or what other people say; they are only interested in facts."

Coming from one who has obviously had a very extensive practical experience with firearms, Mr. Glendenning's remarks are of the greatest interest.

Regarding the process of detonating the cap, it was not intended to go into this in minute detail in the articles, as space would not permit of such detailed treatment of all the many aspects of the subject. I think, however, it was made clear that in the case of the rim fire cartridge the detonating compound was compressed sharply between the folds of metal comprising the rim. Obviously one must have something solid to push against to effect compression; in this case the "something solid" is the recess in the chamber of the rifle. In the centre fire cartridge a rigid portion or anvil must be provided in the cartridge head for the firing pin to compress the detonating compound against. In the British cartridge this is a flat-topped conical protuberance, which is formed centrally in the recess in the cartridge end and is integral with the cartridge head. In other cartridges a separate anvil piece of brass is placed in the bottom of the cartridge head recess. The "arrow head" shaped anvil piece referred to by Mr. Glendenning has, generally speaking, been superseded by a variety of other shapes, common forms being small tripods or bipods.

Even the early forms of cartridge, though they had nothing corresponding to an "anvil," either as a separate part or formed integral with the case, had something equivalent. For instance, the interesting and very successful "pin fire" cartridge had the cap located in a little internal recess in the cartridge head. The radial striking pin compressed the cap between the end of the pin and the base of the recess.

I did mention in the articles that streamlined or boat-tailed bullets are used by the U.S.A. and by the French and Swiss armies. Such bullets were supplied by our own authorities for the Bisley meetings of 1938 and 1939, and I believe British boat-tailed bullets are being used by us in the present war for certain automatic weapons. For short-range firing (up to 400–500 yards) they have little advantage over the square-ended bullet, but beyond that their lower air resistance and consequent better maintenance of velocity show up to advantage.

Mr. Glendenning points to the U.S.A. model of 1917 rifle as being an exception to my statement that we are the only nation that uses five-groove rifling. That particular rifle is a British Enfield design and was made for us by the U.S.A. during the last war, when we were so short of rifles. It was bored to 0·300 calibre to take American ammunition as we were also short of ammunition.

Regarding the variable pitch or "gain twist" rifling, I learn that the Bofors A.A. gun is rifled in this manner. The copper driving band on the shell which engages the rifling of the barrel is, however, very narrow, so that the amount of "overhaul" due to variation of pitch (33 per cent. reduction) is not a very serious matter.

There can be no question but that there must be a rotational reaction on the gun due to giving the bullet spin. The point is whether or not this is sufficiently marked to warrant the adoption of one hand of rifling in preference to the other. A friend of mine who has also handled firearms all his life and has fired thousands of rounds from revolvers and pistols of all types and calibres is just as emphatic on this point as Mr. Glendenning; only he maintains that no rotational kick is detectable. He points out, however, that with some hand guns, particularly automatic pistols, there is a definite tendency for the muzzle to jump to the left when firing with the right hand. This tendency might be mistaken for rotational kick, whereas it is undoubtedly due to the lack of adequate restraint by the thumb, which restraint is, of course, entirely absent when "thumbing the hammer."

I am grieved to note that Mr. Glendenning is at variance with the opinion that the bulk of the noise in a rifle discharge comes from "air splitting." Out of the welter of conflicting opinions on the rifle I thought that this was one point at least on which all authorities were agreed. He certainly seems to stand very much alone in holding his view.

When dealing with silencers I mentioned in passing that these could not, of course, be effective on revolvers on account of the gap between cylinder and barrel. Mr. Glendenning fully agrees with this. To him it is even self-evident. It puzzles me, therefore, how he comes to describe the statement as "ridiculous." To him it may perhaps be "elementary," but surely not "ridiculous."

I am indebted to Mr. Glendenning for the interesting historical details regarding the origin of rifling. I am sorry he found my brief reference to the historical aspect of the matter muddling (for one ghastly moment I thought he was referring to the technical aspect). I can only say my reference agrees with statements made in the "Textbook for Small Arms." It is difficult to see why it should be easier to ram a bullet down a rifled barrel than down a smooth one, yet Mr. Glendenning states that this was the original reason for adopting rifling. In the next sentence, however, he says that rifling was introduced to accommodate the fouling from the black powder then in use. Which is correct?

I was certainly unaware that arrows were given a spin in flight. All those I have seen had feathers fixed in axial planes like the modern dart so as to give straight flight.

It is quite conceivable that a heavy-nosed bullet might give better results than a heavy-tailed bullet if spin were absent or inadequate.

I think Mr. Glendenning has got a wrong conception of the degree of twist necessary in the rifling of a barrel to give a bullet stability. The amount of this twist does not depend on the muzzle velocity of the bullet at all, but solely on the length of the bullet as compared with its diameter. For instance, a 1·5in. long 0·303 bullet would require rifling with twice as rapid a twist as a 0·75in. long 0·303 bullet, no matter what the muzzle velocity of each might be, it being assumed, of course, that the bullets are of the same density.

I do not think that increased spin can appreciably enhance the penetrating powers of the smooth-nosed bullet. As was shown in the first article, the rotational energy stored in the bullet is very small and could not produce any material "drilling effect" even if the bullet were provided with a non-deforming fluted nose.

D. WEIR.

Rugby, August 28th.

SHORTAGE OF ENGINEERS

SIR,—I wish to confirm a statement made in "Young Hand's" letter in your issue of August 29th by my own experiences. I am a section leader in an aircraft factory and the appointments offered to me by the Central Register, some four in number in recent months, have all been of less importance technically and less value financially than that which I now hold. This is surely directly opposite to the proposed policy of upgrading.

I may add also that when I have applied for a post senior to that in which I now am, often through an advertisement in your columns, the reply has always been that the request cannot be considered "in view of the nature of the work in which you are now engaged."

G.

London, August 29th.

THE Crown Agents for the Colonies have appointed Mr. E. T. Williams as assistant engineer, Federated Malay States Railways.

Sixty Years Ago

THE FORTH BRIDGE

IN our issue of September 2nd, 1881, we reported that for some weeks past soundings, borings and other studies had been in active progress to enable the best position for the piers of the Forth Bridge to be determined. It was understood that all the engineers acting for the several railway companies interested in the undertaking—namely, Messrs. Harrison, Barlow, Fowler and Baker—had after independent investigation unanimously reached the conclusion that the safest and most economical method of crossing the Forth would be by means of a continuous steel girder bridge of varying depth and having two spans of from 1600ft. to 1700ft. and two shorter spans of from 600ft. to 700ft. . . . If this report was true, it suggests that Sir John Fowler and Sir Benjamin Baker within the next few years found cause to change their views on the subject in a radical manner. The Forth Bridge as finally designed and constructed is a cantilever structure with two main spans of 1700ft. and two anchor arm spans of 685ft. The correspondence of these dimensions with those mentioned in our report may, however, imply that in 1881 the real decision which was reached was that a cantilever bridge should be constructed and that the unfamiliarity with the cantilever principle then generally prevailing led to the projected design being described as a continuous girder bridge with varying depth. From the point of view of actual practice the Forth Bridge in its finished state is little different from a continuous girder bridge having a total length of 5350ft.

ELECTRIC TRAIN AND MINE LIGHTING

In the same issue we recorded that the Great Northern Railway was about to make a novel experiment in the lighting of railway carriages. The company had contracted with R. E. Crompton and Co. to fit up a train with electric lighting using the Swan pattern of incandescent lamp. The Swan lamp was at that time being tried for several industrial purposes. At the Earnock Colliery in Scotland, for example, twenty-two 15 candle-power lamps were in use underground. The current was supplied by a Gramme dynamo. On the whole the installation was satisfactory, although it was found difficult to obtain equal illumination from all the lamps. This fault was traced to the lamps themselves, the internal resistance of which was found to vary considerably. It was also found that the breaking of a Swan lamp in an explosive mixture of fire-damp could result in the ignition of the mixture.

BRITISH STANDARDS INSTITUTION

All British Standard Specifications can be obtained from the Publications Department of the Institution at 28, Victoria Street, London, S.W.1. The price of each specification is 2s. 3d. post free, unless otherwise stated.

MAGNETIC MATERIALS FOR USE IN COMBINED D.C. AND A.C. MAGNETISATION

B.S. 933. Up to the present there has been no B.S. specification which dealt adequately with the testing of magnetic materials intended to be used under conditions involving combined D.C. and A.C. magnetisation. The specification B.S. 601, Steel Sheets for Transformers for Power and Lighting, dealt with materials which were subjected only to A.C. magnetisation, but for many applications, particularly in communication engineering, the magnetisation is produced by combined A.C. and D.C., this condition being known as incremental magnetisation. To provide for this case a new B.S. specification has just been issued. This specification provides not only for the case of incremental magnetisation, but also for permeability measurement by A.C. methods at frequencies appropriate both to power and to communication engineering technique. It lays down precision methods of iron loss measurement extending into the audio-frequency range which, while framed essentially for the incremental case, actually represents the first standardisation in this country of the A.C. potentiometer and the A.C. bridge in the measurement of iron losses. The specification deals with silicon steel sheets of varying silicon content, and with nickel-iron strip. The size of stamping envisaged is smaller than that with which the earlier specification, B.S. 601, was generally concerned.

WAR EMERGENCY B.S.S. FOR HIGH-TENSILE (FUSION WELDING QUALITY) STRUCTURAL STEEL FOR BRIDGES, &c., AND GENERAL BUILDING CONSTRUCTION

B.S. 968—1941. All high-tensile structural steel has been covered largely by the requirements of B.S. 548, High-tensile Structural Steel for Bridges, &c., but this new specification provides for a special quality for welding purposes. Recent investigations made by the Institute of Welding have shown that unless special precautions are taken when welding high-tensile steel, difficulties may arise due to hardening at the weld boundaries. With a given set of welding factors, the degree of this hardening may be reduced by lowering the carbon content of the steels, and, as a result, special welding quality high-tensile steels are now available with maximum carbon contents considerably lower than the 0·30 per cent. which is allowed by B.S. 548 and with corresponding improved weldability. This specification relates to steels of this type, in which the carbon content is limited to a maximum of 0·23 per cent., and which are designated "high-tensile (fusion welding quality) steels," abbreviated to H.T.W. steels. The material covered is suitable for fusion welding, but is not suitable for forge or smith welding.

The Railway Oil Engine*

By BRIAN REED

PRINCIPAL TYPES

FIVE main types of railway oil engine are in service at the present time, viz.:—

(*a*) Light railcar engines of 65 to 150 B.H.P., and running at 1250 to 2000 r.p.m.

(*b*) Railcar and fast train engines of 200 to 650 B.H.P., and running at 1250 to 1800 r.p.m.

(*c*) Low-power locomotives and tractor models, giving 20 to 150 B.H.P. at 700 to 1200 r.p.m.

(*d*) Low-speed heavy engines of 200 to 600 B.H.P. at 600 to 1000 r.p.m., for shunting locomotives.

(*e*) High-power engines for main line locomotives, of 1000 to 2200 B.H.P., and usually running at 700 to 800 r.p.m.

The general average particulars of these five classes may be summarised as follows:—

(a) *Light Railcar Engines.*—Four-cylinder and six-cylinder models of 5 to 12 litres capacity, running at 1250 to 2000 r.p.m., having a specific weight of 12 lb. to 17 lb. per B.H.P., and a mean effective pressure of 80 lb. to 90 lb. per square inch. The engines differ from their road prototypes in having cast iron crank cases, larger sumps, greater oil circulation, and mountings and auxiliary drives suited to railway conditions.

(b) *Railcar and Multi-unit Train Engines.*—As a rule, these are of the six-cylinder vertical type in the lower and middle ranges, and of the V type in the upper range, but horizontal engines with two cylinder banks are used also for powers of 170 to 300 B.H.P. Adoption of the horizontal engine is solely to enable more of the car floor area to be used for revenue earning. Pressure charging is popular in this range. In many respects the big V engines of 300 to 500 B.H.P. (400 to 650 B.H.P. when pressure charged) are the highest commercial development of the lightweight high-speed oil engine. Average figures for the whole range are:—1400 to 1500 r.p.m.; specific weight, 12 lb. to 18 lb. per B.H.P.; mean effective pressure, 85 lb. to 90 lb. per square inch. By the incorporation of pressure charging the dry weight is brought down to 9½ lb. to 13 lb. per B.H.P., and the mean effective pressure raised to anything from 100 lb. to 120 lb. per square inch. Typical examples of the V engines are the Maybach 12-cylinder 450 B.H.P. (650 B.H.P. pressure charged), Saurer 300 B.H.P., Renault 12-cylinder 300 B.H.P., and 16-cylinder 500 B.H.P. It is the Maybach engine in both its normal and pressure-charged forms which is used in the German streamlined trains and in others in Holland, Belgium, and France. Up to 300 B.H.P. the vertical engine is usual, and representative models are the Sulzer 6LDT19 engine, giving up to 300 B.H.P. at 1175 r.p.m.; the Saurer pressure-charged BXDA model of 225 B.H.P. at 1500 r.p.m. (the normal BXD engine gives 160 B.H.P. at the same speed); the English Electric K model with a top output of 220 B.H.P. at 1500 r.p.m.; and the Ganz 6-cylinder engine, giving 240 to 250 B.H.P. at 1250 r.p.m. Almost alone among first-class railcar engine makers, Ganz has an 8-cylinder model, which is set to give between 320 and 365 B.H.P. at 1250 to 1350 r.p.m., according to the duties.

(c) *Low-power Locomotive and Tractor Models.*—Typical English makes in this category are the Gardner L3 range of 125 to 200 B.H.P., running at 1200 r.p.m.; the large Paxman range from 50 to 200 B.H.P., running at 900 to 1000 r.p.m.; and the McLaren and Fowler-Sanders engines, also from about 50 up to 180 or 200 B.H.P. At the lowest end of the power scale, 2-cylinder engines are not uncommon, and in Continental designs the 2-cylinder two-strokes of the Deutz, Jung, Hatz, and Junkers patterns are common for powers of 20 to 35 B.H.P. The unit weights, apart from the Gardner engines, are practically always well over 25 lb. per B.H.P. in the dry condition.

(d) *Low-speed Heavy Engines.*—In the low-power range these engines overlap with those in the higher range of category (*c*). An output of about 350 B.H.P. is almost a standard for heavy shunters, apart from North America. Two English examples are the English Electric H series set in the L.M.S.R. locomotives to give 350 B.H.P. at about 675 r.p.m. on a specific weight in excess of 60 lb. per B.H.P. (mean effective pressure 72 lb. per square inch and piston speed 1370ft. per minute); and the Armstrong-Sulzer 6-cylinder engine with a top setting of 400 B.H.P. at 1000 r.p.m., on a specific weight of 22 lb. per B.H.P. (mean effective pressure 81 lb. per square inch and piston speed 1835ft. per minute). These two engines form an interesting contrast of about the heaviest and lightest types suitable for big shunting locomotives. Observations on the L.M.S.R. machines indicate that 350 to 400 B.H.P. is more than required for the heaviest work in England, and that 300 B.H.P. is quite enough if allied to a transmission with suitable speed-tractive effort characteristics. In the U.S.A., engines of 300 B.H.P. have been largely superseded by others of 600 to 1000 B.H.P., but the locomotive weights are 80 to 110 tons, compared with the 48 to 55 tons of the English-built 350 B.H.P. type. Pressure charging has been adopted for some of the American 1000 B.H.P. machines, and also for some French Sulzer-engined shunters of 635 B.H.P.

(e) *High-power Locomotive Engines.*—Apart from the General Motors range of two-strokes in the U.S.A.—900 to 1350 B.H.P.—modern engines of this type are resolved into two makes, viz., Sulzer and M.A.N., and in each case pressure charging is a standard feature. The M.A.N. engines are nominally of 1000 to 1050 B.H.P. and 1300 to 1400 B.H.P., and although the top rotational speed is only 700 r.p.m., the specific dry weight does not exceed 14 lb. to 15 lb. per B.H.P., a result which has been obtained by welding the complete engine frame and by the use of pressure charging. The Sulzer engines are of 1200 and 2200 B.H.P., the second being a twin-bank engine in which the drive from the two crankshafts is transmitted to the electric generator through step-up gearing. The top speed in each case is 700 r.p.m., the specific weight 20 lb. to 21 lb. per B.H.P., and the mean effective pressure about 115 lb. per square inch.

TABLE I.—*Railway Oil Engine Characteristics*

Make.	Maker's type.	Lay-out.	No. of cyls.	Max. service B.H.P.	R.p.m.	Cylinder bore and stroke, in. or mm.	Weight per B.H.P., lb.	M.E.P., lb. per sq. in.	Piston speed, ft. per min.
Light Railcar Engines, 65 to 160 B.H.P.—									
Gardner	6 L.W.	Vertical	6	102	1700	4·25×6·0	16	93	1700
A.E.C.	—	,,	6	105	1650	120×142	—	86	1545
Leyland	10-litre	,,	6	120	1850	4·62×6·0	17·3	85	1850
Fiat	357	,,	6	145	1700	125×175	20	87	1960
Saurer	B×D	,,	6	150	1500	130×180	17·4	90	1770
Renault	—	,,	6	150	1500	140×170	17	82	1670
Daimler	OM54	,,	6	150	1500	125×170	15·3	104	1685
Railcar and Train Engines, 170 to 550 B.H.P.—									
English Electric	K	Vertical	6	220	1500	6·0×8·0	20·5	85	2000
Ganz	VIJaR170	,,	6	275	1350	170×240	18	81	2110
Renault	517	V	12	300	1500	140×170	16·1	82	1670
Saurer	BZD	,,	12	300	1500	130×180	16·4	90	1770
Sulzer	6LDT19	Vertical	6	300	1175	190×240	16·9	81	1860
Ganz	VIIIJaR170	,,	8	365	1350	170×240	17·8	81	2110
M.A.N.	L12V	V	12	420	1400	175×180	15·3	76	1635
Maybach	GO56	,,	12	450	1400	160×200	11·5	88	1840
Renault	504	,,	16	500	1500	156×180	16·3	77	1770
Sulzer	6LDT25	Vertical	6	500	900	250×310	17·6	79	1835
D.W.K.	2x4V18L	Horizontal	8	180	1500	128×180	16·3	83	1775
German Standard	—	,,	12	275	1500	130×190	18	79	1870
Low-Power Locomotive and Tractor Engines, 20 to 160 B.H.P.—									
Paxman	—	Vertical	6	65	1000	4·62× 5·87	33	88	980
Fowler-Sanders	4C	,,	4	150	1000	7·0 × 9·0	41	85	1500
Gardner	6L3	,,	6	153	1200	5·5 × 7·75	—	91	1550
Gleniffer	DC8	,,	8	160	900	6·0 × 7·0	—	89	1050
Low-Speed Heavy Engines, 180 to 600 B.H.P.—									
Paxman	—	Vertical	8	180	1100	5·5 × 7·0	—	96	1285
Vulcan-Frichs	6215CL	,,	6	275	775	8·5 ×11·0	31	76	1420
English Electric	H	,,	6	350	675	10·0 ×12·0	64	72	1370
Armstrong-Sulzer	—	,,	6	400	1000	8·65×11·0	22	81	1830
Niigata	—	,,	8	500	900	9·85×11·42	—	64	1710
High-Power Main Line Locomotive Engines, 1000 to 2200 B.H.P.—									
M.A.N.	—	Vertical	6	1050	700	300×380	14·0	120	1750
	—	,,	8	1400	700	300×380	17·0	120	1750
Sulzer	6LDA28	,,	6	1200	750	280×360	21	115	1780
	12LDA31	(twin bank)	12	2200	700	310×390	25	115	1795

BASIC REQUIREMENTS

The railway oil engine must give reliable service over long periods without the uneconomic use of the constructional materials; it must operate economically as to fuel and oil, and have load-carrying ability, over a wide range of speed; and the maximum output to which it is set must be varied for each order and limited to a proportion of the maximum possible test bench figure, which will ensure a reasonable engine life. The torque curve should be fairly flat, but should retain the drooping characteristic which is suited to traction work. In bulk, the engine must be small enough to fit into a railcar or locomotive harmoniously with other constituents, and must not necessitate an unwieldy design of the complete vehicle. Again the rotational speed must be high enough to prevent transmission parts from becoming bulky and weighty, and thus, in their turn, affecting the vehicle design, the maximum axle load, the total weight, and the weight distribution.

Finally, and at the present stage most important, it should have the minimum practicable amount of

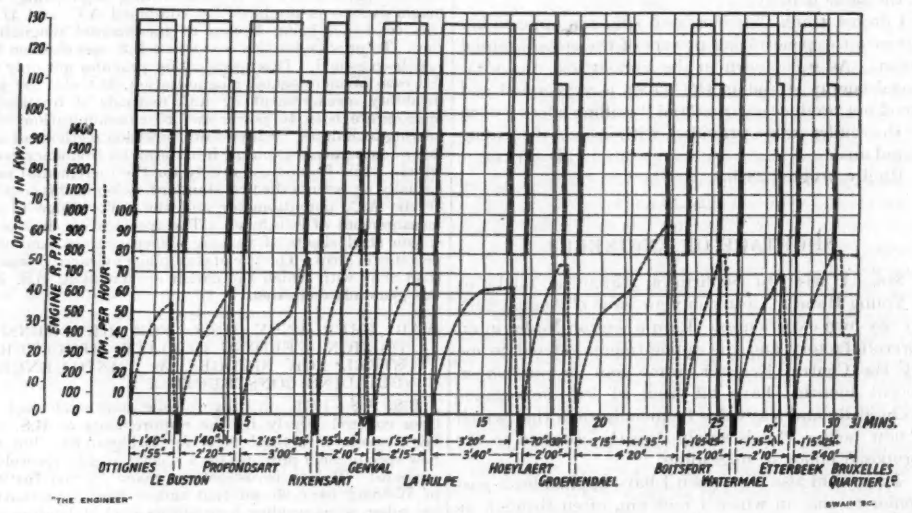

FIG. 1

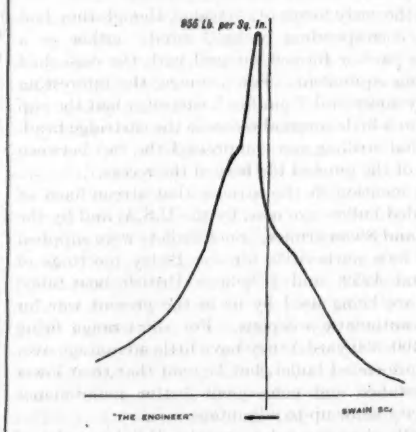

FIG. 2

* The Diesel Engine Users Association—Abstract.

control apparatus and as few auxiliaries as possible. The extreme importance of this must be emphasised, because railway oil engine design and construction has advanced so considerably in the last three or four years that something like 85 per cent. of all the failures attributable to the power portion may be caused by delicate, and often unnecessary, control mechanism or by auxiliaries and their drives.

The relative importance of the above-named requirements varies between engines of categories (*a*) to (*e*). For example, bulk and speed and weight are prime considerations in the design of engines for railcars and multi-unit trains, but not for heavy shunting locomotives. On the other hand, engines installed in shunters engaged in heavy yard service must be capable of withstanding repeated and rapid loading and unloading over twenty-four hours a day and for six or seven days a week; their fuel consumption at full load is not, as such, particularly important, for they rarely reach full load, and then only for a matter of seconds. But as they do spend quite a lot of time idling, the idling speed should be as low as possible, and away from criticals of the engine or of any elastic mounting it may have.

Output and Duties

Complication is added when the same engine is used for a wide variety of applications. All that can be done—or rather is done—is to limit the maximum output according to the supposed severity of the duties. For example, the Maybach 6-cylinder engine nominally considered as giving a top output of 210 B.H.P. (225 B.H.P. in the most recent models) is often used for light branch-line railcars running at overall speeds of 22 to 27 m.p.h., with stops every 2 or 3 miles. But the same engine has been used in Belgium on accelerated local railcar services over heavy-gradient lines without any change in the power characteristics. How severe is the duty thrown on the engine in this service may be seen from Fig. 1. The engine speed and load are right up and down again every few minutes, and actually the car used to make twenty such trips—ten out and ten home—every day. On the out-and-home runs the engine developed full output from 76 to 67 per cent. of the total running time, and 16 to 19 per cent. of the time idling. As a rule, such duties are incomparably more onerous than running steadily for long periods at or near the full service output, and the mileage between heavy overhauls would be correspondingly less.

Characteristics and Operation

A combination of constant-pressure and constant-volume combustion is a characteristic of most of the quick-running lightweight engines, but some of them get fairly near "explosive" combustion, as shown in Fig. 2, which is a reproduction of a cylinder-pressure diagram taken from an M.A.N. engine with 175 mm. by 180 mm. cylinders and running at 1500 r.p.m. The magnitude of the peak pressure is probably typical of engines of this size (280 B.H.P.), but it may be as well to point out that the stroke-to-bore ratio is not typical of railway models. Some of the small quick-running engines developed from road models have peak pressures of 1100 lb. to 1300 lb. per square inch, and have really no constant-pressure combustion characteristic at all.

Ratings

A considerable amount of misconception appears to exist as to the "ratings" of railway oil engines. Actually, there is no such thing as a "rating," and there cannot be. All that can be done is to give a definite maximum setting to the fuel pump and to govern the maximum speed. Not only do the duties of every batch of railcars or locomotives vary from the others, but over any given run the power and speed are varying every minute, and it does not seem possible to summate the engine duties in any way which would be of use. Little attempt is made to vary maximum engine power and speed for different duties, and little trouble is caused by this omission, simply because the engine service output is so far within the maximum possible power that the engine is being used uneconomically.

One sees such things as continuous, one-hour, and 10-min. ratings specified or stated, but this introduction of the time element does not seem to fit in too well with the elementary principles of oil engine operation. It is true that for a few things, such as piston and ring temperatures, the introduction of a time element may be of value, but only if previous and subsequent operating conditions are specified—which they are not. Otherwise, any temperature rise which can occur, short of defective operation, will take place in so short a space that the length of time of the rise is of scant importance in obtaining an idea of the output.

Where time limits are of consequence is in the life of the engine, but the period involved is so long that it cannot be correlated to short-time performances, or even to such trials as the seventy-two-hour continuous tests which used to be given by the French National Railways. Even with the maintenance of the maximum possible test bench output, the length of time before the failure of certain constituents highly stressed mechanically or thermally is a matter of hundreds of hours.

The one basic figure seems to be the maximum possible output, limited by exhaust smoke and temperature, on the test bed, and no other fact about the output capacity can be ascertained on the bench if the test be extended to ten hours or fifty hours. The proportion of the maximum output (governed principally by heat stresses) and top speed (governed by mechanical stresses) should be controlled by the actual service conditions of each application, but they are in no sense "ratings" and are computed—or should be—from the experience of the maker and the user. Wherever possible the customer should obtain the maximum possible test bench output and top speed of the engine which it is proposed to supply, and also a fuel consumption curve plotted right up to those top limits. And he should insist on all tests being carried out with the brand of fuel oil he is going to use when the engine is in traffic.

Pressure Charging

In railway work probably more than in any other avenue of diesel engine application, pressure charging shows up to advantage and has been quite widely applied during the last two or three years, not only to gain power on ordinary railways, but also to compensate for the loss in power at altitudes up to 15,000ft. Pressure charging has been the greatest single factor in improving the power-weight and power-bulk ratios of practically all types of railway four-strokes, and, in addition, has given a greatly enhanced general performance. Engines of ordinary good quality can have their service output at top revolutions per minute increased by 25 to 30 per cent., and more conservatively limited engines by 40 to 50 per cent. Apart from French and French Colonial practice, and one or two experimental applications of gear-driven blowers, the Büchi system of exhaust gas turbo-charging is universal. In early applications the increase in power became greater as the upper limits of output and speed were reached, but further investigations made it possible to give appreciable proportionate increases in power and torque at comparatively low engine speeds—which are of the greatest value in railway work.

Two further outstanding advantages in traction work are the flatness of the fuel consumption curve over practically the whole working range of speed, and the amount of excess air, which gives a cool engine, considerably reduces the amount of heat lost to the cooling water per unit of engine output, and thus permits of greatly increased engine outputs without any increase in the size of the water and oil radiators. As a rule, there is a slight increase in the maximum cylinder pressure of a pressure-charged engine, even when the compression ratio has been lowered slightly. As an example, the peak pressure in the M.A.N. engine from which Fig. 2 was taken rises from 955 lb. to 1000–1015 lb. per square inch, when a turbo-charger is fitted to give a charging pressure of 3 lb. per square inch above atmospheric, but the rate of pressure rise is considerably slower. The pressure-charged output is 350 B.H.P. at 1500 r.p.m., compared with the 280 B.H.P. of the normal engine.

Aims and Scope of the Mechanical Engineering Curricula*

By A. G. CHRISTIE†

THE writer's views of what constitutes a mechanical engineering curriculum are unorthodox. An eminent engineer claims that there should be only one curriculum for all undergraduate engineering students, which should embrace the fundamentals of the several branches of engineering. There is justification for this view, for my professional work, both here and abroad, has presented problems in the fields generally embraced in mechanical, electrical, civil, gas, mining and chemical engineering, and these problems had to be solved. This has required more than a cursory knowledge of certain portions of these branches of engineering. My three years of college training were largely devoted to electrical studies, and my work has been principally mechanical since leaving college. As a consequence my ideas of curricula are somewhat liberal.

What is mechanical engineering? A committee of the American Society of Mechanical Engineers has recently submitted the following definition:—

"Mechanical engineering comprises the art and science of power generation, the transmission of power, and transportation by mechanical devices; of the production of machinery, tools and their utilisation; and it includes research, design, development, application and the management functions of organisation, operation, maintenance and marketing."

This definition covers the various fields of activity of the mechanical engineer. Curricula must aim to prepare students for usefulness in these activities.

The aims of a curriculum and of the teaching that puts it into effect should be the development of a well-trained undergraduate. He will not be a mechanical engineer upon graduation, for there will be much to learn of the art of engineering before he reaches competency. What is embraced in the term "well-trained"? Opinions differ. Some employers ask for graduates versed in the details of only a particular branch of the profession. The need of a knowledge of the fundamentals of other branches of engineering can be emphasised by the following illustrations.

In the field of power plant design one needs to know something of structures to pass upon foundation designs; of fluid mechanics to appraise water channels or hydro installations and ducts or conduits for air or gas flows; of chemistry to determine feed water treatments; of materials to select suitable piping and other parts for high-temperature steam; of electricity to choose auxiliary motors, control systems, communications and lighting; and of heat generation, transfer and transformation, as applied to boilers, turbines, extraction heaters, de-aerators and condensers.

In manufacturing industries the mechanical engineer should know materials, their physical and chemical properties, metallographic structure, weldability and heat treatment; in design, one should evaluate the elastic properties of materials and their vibration characteristics; in shop administration, there is needed an understanding of machines, processes, material handling, labour policies, cost accounting and business methods.

As a useful citizen, the engineer should understand our political organisation and governmental methods, the history of our institutions and the trend of social development. He should take his share of the responsibility in securing good government and in controlling the application of his technical developments. He should be able to express his views to his fellow-citizens in simple, forcible English.

One's first conclusion is that these requirements call for highly specialised training in each case. On second thought, however, it will be seen that a graduate "well trained" in English, the principles of mathematics, physics, chemistry, mechanics and materials and in the fundamentsls of thermodynamics, electricity, structures, political economy and industrial organisation would readily comprehend the various problems that would present themselves and would know how to go about their solution. Thorough instruction in such courses should be the aim of a mechanical engineering curriculum. Its scope may be broadened in the final year by certain application courses to train the student in the use of these fundamentals.

The principles of the basic courses of mathematics, physics, chemistry and mechanics should be taught with the greatest thoroughness. This teaching can be more effective if the student is shown the application of each of these sciences to engineering problems, which presentation arouses his interest in the subject. The engineer should consider mathematics through differential equations as one of his tools and be as competent in its application as a mechanic with hammer and chisel. More and better chemistry is needed, for much of the engineer's later work will require the application of this chemistry. A grasp of classical physics which includes the properties of matter, theoretical mechanics, the laws of gases, heat, electricity, magnetism, optics, and sound is preferable to discussion of modern physics, which concerns itself with the constitution of the atom, relativity, &c. The engineer needs to know these principles to understand radiant heat transfer, sound intensity, wave motion, spectroscopic analysis of substances, optical measurements on surfaces and supersonic phenomena. Mechanics forms the basis for the analysis of forces in machines and structures. It should include not only the tensile, compressive and torsional statically applied forces, but also the dynamic forces that may be present, the resultant strain on the loaded parts, their natural periods of resonance and graphic methods for the solution of problems.

These basic courses are generally offered in the first two years, together with English, drawing, descriptive geometry, surveying, mechanism and in many cases shop work.

The curriculum of the third and fourth years differs greatly among the colleges. This is the portion upon which there can be placed much thought for the optimum development of the "well-trained" man. The fundamental courses have already been stated. These courses, given in the last two years, should emphasise in the classroom the theoretical treatment and should continually show the application of the mathematical, physical or chemical principles learned in the first two years. Descriptions of machines and processes should be at a minimum, leaving to the laboratory and to visits to plants the functions of familiarising the student with current types and their operation.

Many schools have found that a course in English offered in the last year is helpful. Students at that stage realise the need of training in clear exposition, both oral and in writing, and hence take a greater interest in and get more out of an English course of this character than at any other stage in their college careers.

One will object that this programme favours a curriculum of engineering fundamentals only and that little specialised training in mechanical engineering

* Abstract of a paper read before a conference at Purdue University, U.S.A.

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is contemplated. After all, is not this a desideratum in a well-planned four-year course? Few students in college have a definite idea of their field of work immediately after graduation, let alone ten years afterwards. In view of the rapid developments in the past and even more extensive ones in the future, a thorough knowledge of fundamentals is essential. With the latter, an engineer can readily comprehend the changes in practice and can soon acquaint himself with the details of a new development. In other words, the specialised student is narrowly limited and has difficulty in adjusting himself to changes. Our "well-trained" graduate is versatile and is prepared to carry his share of the work in this changing world.

In closing let me repeat again that the curriculum of mechanical engineering should emphasise the principles of mathematics, physics, chemistry and mechanics, that emphasis should be placed upon fundamentals rather than practice in thermodynamics, electricity, structural design, fluid flow and materials, and that English, political economy, industrial organisation be emphasised. Other courses, even the mechanic arts, should receive lesser emphasis. The completion of such a curriculum should lead to a "well-trained" engineer.

High-Production Centre Lathe

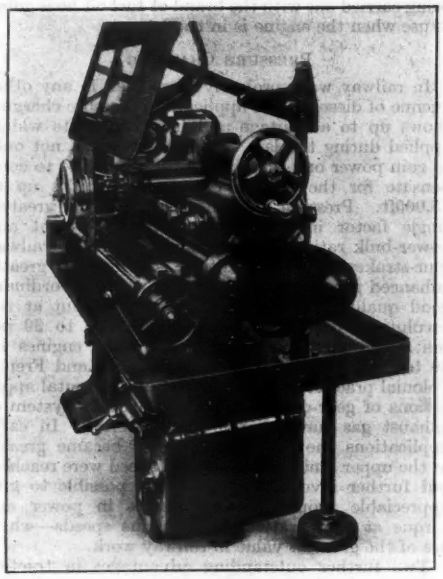
THE machining of small shafts with one or more diameters is usually done on a centre lathe, hexagon turret lathe or multi-cut lathe, according to the size of batches. According to Alfred Herbert, Ltd., none of these machines combines the advantages of the accuracy obtainable by means of single-tool cutting and the high speeds possible by the use of Ardoloy or other high-speed cutting alloys. That firm has therefore produced the "Carbicut" lathe, illustrated on this page, which is claimed to combine those desirable features and to produce work to closer limits of accuracy and concentricity than is possible by multi-tool methods, thus effecting savings on subsequent grinding operations.

Material.	Depth of cut.		
	⅛in.	¼in.	⅓in.
	Cutting speed, feet per minute.		
Carbon steels :			
0·1 to 0·18 per cent. carbon ...	700	750	800
0·25 to 0·35 per cent. carbon ...	500	650	700
0·38 to 0·5 per cent. carbon ...	450	500	600
0·75 to 0·85 per cent. carbon ...	300	350	400
Carbon-chromium steels :			
0·4 to 0·5 per cent. carbon	350	400	450
0·7 to 1 per cent. chromium			
Special tool steel :			
0·90 to 1·1 per cent. carbon ...	200	250	300
1·20 to 1·60 per cent. chromium ...			
Nickel-chrome steels :			
3½ per cent. nickel-chrome	400	500	600
Air hardening			
1·5 to 2 per cent. nickel-chrome ...	300	400	500
Oil hardening			
3 to 4 per cent. nickel-chrome ...	450	550	750
Case hardening...			

From experience with this machine the firm recommends cutting speeds for steel bars using a feed of seventy cuts per inch as listed in the accompanying table.

A comparison with the cutting speeds generally used on bar lathes and multi-cut lathes which with high-speed steels are usually from 60ft. to 160ft. per minute for similar work, gives some indication of the productive capacity of the "Carbicut" lathe. Generally speaking, production is said to be twice that obtainable on a capstan lathe, and to exceed that of a multi-cut lathe on small quantities, in addition to turning to closer limits. Setting times are often considerable on multi-cut lathes and must be allowed for when arriving at production figures.

The tooling is of a very simple nature. The diagram shows the tools used for machining a three-diameter shaft. Turning is done with an "Ardoloy" tangential turning tool in the patented "Chipstream" tool post at the rear of the cross slide, the work running in the normal direction. This tool is mounted at an angle to give the desired front and side clearances, the cutting face being on the end of the tool. A setting block is supplied for setting the tool to the correct height. The tool will take cuts up to ¼in. deep at high speeds. All danger to the operator, owing to the speed at which turnings come from the work, is avoided by the provision of a chip breaker fitted to the rear tool post, which breaks up the turnings into small lengths. In addition, a special swinging guard fitted with armour plate glass windows is provided. The square turret at the front of the cross slide carries facing, undercutting and chamfering tools.

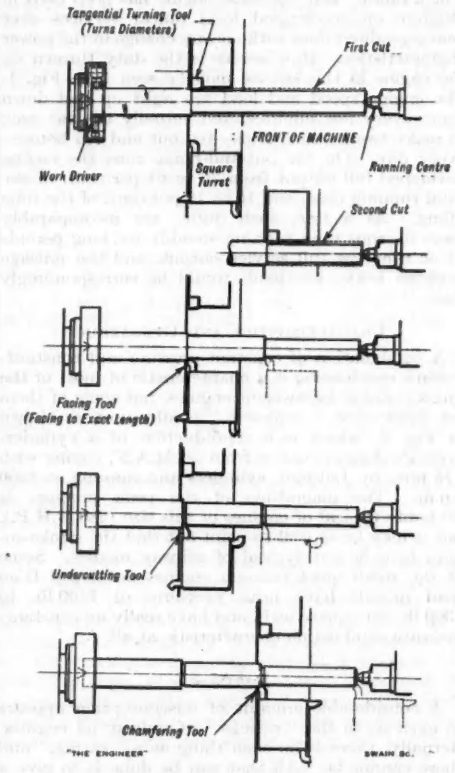


END VIEW OF LATHE

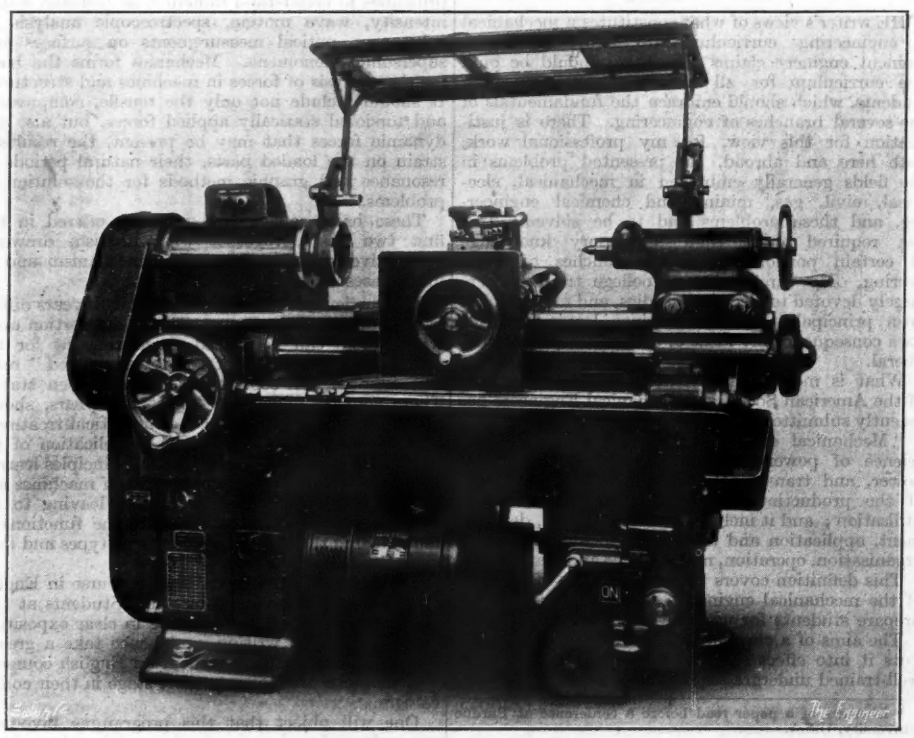
In addition to hand motion the saddle is fitted with quick power traverse of 200in. per minute in both directions. It is engaged by a finger-controlled lever at the right-hand end of the machine, the lever being moved in the direction in which it is desired to traverse the saddle. Sixteen speeds from 445 to 3025 r.p.m. are provided by pick-off gears, enabling any material to be machined at the highest practicable speed. Two instantaneous speed changes with a ratio of 1½ to 1 are obtainable by means of push buttons, which can be operated while the machine is running. Smaller diameters can therefore be turned at the higher speed. Automatic feeds of 70, 105 and 140 cuts per inch are suitable for the range of turning speeds provided, the coarsest feed being that generally used. Diameters can be accurately duplicated in either direction by four rotatable barrel stops on the cross slide. The cross slide traverse screw is fitted with a micrometer dial, each division representing 0·002in. Lengths are duplicated by adjustable stops on a rotatable hexagonal stop bar at the front of the lathe. A dead stop is also provided. It is used in conjunction with the hand wheel fitted with accurate indicators which regulate the pressure on the stop and so enable length dimensions to be accurately duplicated.

A work carrier with three-screw adjustment covers the full range of diameters from ⅜in. to 2¼in. When changing similar work pieces no loose spanner is necessary. One of the adjusting screws is inserted in a slotted plate fixed to the machine and the work piece itself is used as a lever to slacken or tighten the screw. A slotted work driver fitted to the spindle ensures with safety quick insertion of the work on the centres.

The machine spindle is mounted on ball and roller bearings and a ball and roller bearing running centre is fitted in the tailstock. The tailstock is of a patented spring-loaded type, which allows for work expansion due to heat and avoids damage to centres and ball races. The bed of the machine is hardened by the "Flamard" process, which gives a hardness on the prismatic guide ways of 478/555 Brinell. The saddle is fitted on one side with covers in contact with and sliding on the ways of the bed. Diagonal bracing gives stiffness and wide chip space, permitting chips to fall through the bed to the chip tray. The machine is entirely self-contained and is therefore particularly easy to install. No special levelling is required, as three-point contact with the floor is provided and when installed on its site it is only necessary to connect the machine to the electrical supply.



TURNING THREE-DIAMETER SHAFT



"CARBICUT" LATHE

All the electrical contactor gear, main isolating switch and fuses are housed in a cabinet beneath the right-hand end of the machine. The cabinet door is connected to the isolating switch, which cannot be switched on until the door is closed. A no-volt release is incorporated to prevent the machine being re-started, should the current fail, until a push button on the right-hand cabinet is pressed.

The main drive is by a 5 H.P. two-speed flange-mounted motor driving a speed change box in the left-hand cabinet. Speeds are varied by means of pick-off gears on splined shafts. Quick-change retaining washers on the end of the shafts enable the gears to be changed in a few seconds. The operator when changing gears is protected by a safety device which automatically cuts off the electrical supply to the main motor when the door is opened. The drive is transmitted to the spindle by multi-vee ropes, which obviate vibration. Belt tensioning is effected by turning the gear-box, the belt pulley being mounted

excentrically. The spindle is started and stopped and fast and slow speed changes are effected by three push buttons on the headstock, the spindle being brought to rest almost instantaneously by an electrical plugging relay. Automatic feed of the saddle towards the headstock is provided by a feed box driven from the main spindle by a flat belt. Three feed changes can be obtained by moving a small lever on the front of the box and the feed is engaged or disengaged by means of a ball-ended lever. Hand traverse to the saddle is provided by hand wheel fitted with accurate indicators, which is interlocked electrically with the quick power traverse. Before the latter can be engaged the hand wheel must be pulled outwards. Dangerous high-speed rotation of the hand wheel is thus prevented. The quick power traverse is driven by an independent fractional horse-power motor driving a pulley on the end of the feed screw.

The equipment supplied with the machine includes all electrical equipment for 400/440 volts, three-phase, 50 cycles, four pairs of pick-off gears, three Ardoloy tangential turning tools and chamfering, grooving and facing tools for the square turret.

The leading dimensions are as follows :—

Diameter of work turned	¾in. to 2¼in.
Maximum length admitted between centres	22in.
Number of spindle speeds	16
Range of slow speeds	445 to 1990 r.p.m.
Range of high speeds	676 to 3025 r.p.m.
Automatic feeds to the saddle ...	70, 105, 140 cuts per inch
Quick power traverse to saddle ...	200in. per minute
Floor space occupied	6ft. 6in. by 4ft.

PIGEON POST OF SEVENTY YEARS AGO

An interesting discovery of an "Airgraph" service seventy years ago when Paris was besieged during the Franco-Prussian War of 1870–71 has just been made in the archives of the G.P.O. It appears that by means of micro-photography and the use of homer pigeons more than 100,000 messages were exchanged between the citizens of Paris and those resident in all parts of the French Republic. At first this novel form of communication was limited to Government officials. Later, it was extended to the general public. The pigeon depot was stationed in Tours, and the photographic work was done in the same town until it had to be abandoned to the Prussians, and the department moved to Bordeaux. An experimental photographic station which had been set up at Clermont Ferrand was also transferred to and continued at Bordeaux when Tours fell.

The method adopted was as follows. A large number of messages were printed on special sheets and posted up on a board which would hold nine or sixteen sheets. The board was photographed on to a film, and each film contained 1800 or 3200 letters of the alphabet, according to whether nine or sixteen sheets were photographed. From twelve to eighteen of these films, containing 30,000 to 40,000 alphabet letters, were rolled and inserted in a quill and attached to the tail feathers of the pigeon. On arrival at the Paris Post Office a few hours later the films were enlarged on a screen by a magic lantern and copied and delivered to the addressees. After the first trials the delivered copies were reproduced and enlarged by photographic operation, and transcription was thus eliminated, saving considerable time in distribution to addressees.

The excellent results obtained by the photographic method enabled the service to Paris by pigeon post to be extended to the public. A notice authorised any person resident in the Republic to correspond with Paris by pigeon post. There were essential conditions that these letters should be posted open without cover or envelope and registered; that they should be restricted to twenty words; that they should be written in French in clear and intelligible language, and that they should relate solely to private affairs and contain no allusion either to the war or to politics. The charge was fixed at 5d. for each word (the name and address counting as one word) and 6d. for registration. The State did not guarantee the arrival, and no compensation or refund of charges was considered. Correspondence from all corners of France was considerable, and the inhabitants of the capital were thus able to receive news of their parents and friends in the provinces. A number of letters were sent from London.

In 1854 the French had previously experimented with swallows as "aerial postmen" carrying letters from Vienna to Paris. The experiment was only partly successful and was abandoned.

CANADIAN RAIL BOOM.—The combined gross earnings of the Canadian Pacific and Canadian National Railway Companies in the first six months of this year aggregated 241,555,488 dollars, an increase of 52,487,937 dollars, or 27·9 per cent. compared with the first half of 1940. These were the highest figures for the first half of any year since 1929, when combined gross earnings totalled 254,318,820 dollars. For the first half of 1940 the combined gross revenues of the two systems totalled 189,067,551 dollars, an increase of 26·5 per cent. over the corresponding returns for 1939.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

The Control of Iron and Steel

Under the Control of Iron and Steel (No. 15) Order, 1941, the Minister of Supply has issued the following Direction :—(1) Notwithstanding anything in Article 1, 2, or 3 of the Order, any iron (not being pig iron) mentioned in the First Schedule to the Order may, up to and including September 30th, 1941, be acquired without licence by (and disposed of accordingly to) any Government Department, undertaking or person, who immediately before September 1st, 1941, is both (i) a Government Department, undertaking, or person referred to in head (*a*) or (*b*) of Paragraph 4 of the Control of Iron and Steel (No. 8) Order, 1940, Direction No. 1 (*b*), and (ii) party to a contract made for any purpose prescribed in that head in respect of that Government Department, undertaking or person, and may be treated, used and consumed for that purpose; provided that nothing in this paragraph shall authorise a stockholding merchant to acquire any iron, except iron (not being pig iron) delivered directly from the supplier of the stockholding merchant to a customer of the stockholding merchant. (2) The Fourth Schedule to the Order is hereby varied in item "(viii) Iron Casting" therein, by substituting for the expression "2 cwts." the expression "5 cwts." (3) This Direction shall come into force on August 31st, 1941, and may be cited as the Control of Iron and Steel (No. 15) Order, 1941, Direction No. 2.

The Pig Iron Market

Satisfactory conditions continue to rule in the pig iron market, although there is naturally some grumbling from consumers at the difficulty of getting the particular brands they require. There is still a shortage of hematite iron and the Control, wherever possible, presses the use of substitutes. The shortage of this iron, however, is probably largely due to the reduction in the imports of hematite ore, but the Control is carefully watching all iron and steel imports with a view to conserving shipping space. The home production of basic iron is well maintained and the requirements of the steel works are being met. This is regarded as being satisfactory, since it is obviously of the first importance to maintain steel production at a high level. On the North-East Coast attention is concentrated upon producing iron for the steel works, and only comparatively small tonnages of foundry and hematite iron are being produced. Local consumers obtain their supplies from the Midlands, but occasionally it is possible to obtain small parcels of Cleveland iron. The fact that the use of Midland foundry irons involves longer railway haul does not affect the price position, as the cost of delivery is included in the price, which is the same as the Cleveland quotation. The Midland foundries are producing at a high rate of capacity, but whilst there is a steady demand for high-phosphoric iron the requirements of consumers of this description are not so heavy as to throw a strain upon the producers. The Control has been liberal in its allocations to users and views with favour the accumulation of stocks for use during the winter months. In Scotland all the available plant is in operation, and although the demand is heavy consumers are obtaining regular supplies. The Scottish light castings industry is still working at well below capacity and its pig iron requirements are much below normal. Most of these firms are supplied from the Midlands and the price of the Midland iron is 1s. 3d. below the price of the Cleveland iron which they formerly used.

Scotland and the North

All the available plant at the Scottish steel works is fully employed and the whole production is going into consumption almost entirely upon work of national importance. The shipyards are taking very large supplies of plates, although the pressure upon the producers is not quite so heavy as a few weeks ago. In addition to the shipyards, locomotive builders and wagon builders are busily employed and their requirements are considerable. The demand for structural steel, however, is still on the quiet side, particularly for the heavy descriptions. The call for the lighter sections is well maintained and the production of this class of steel continues at a high rate. Producers of forgings and castings have a considerable amount of work on hand and are likely to remain busy for months to come. All the engineering establishments in Scotland are fully employed, most of them upon Government work, whilst the marine engineers are particularly busy. There is still an insistent demand for alloy steel for the munition makers, and the big production of this class of material is one of the features of the market. In the Lancashire district there is a strong demand for plates from the tank and boilermakers, and in fact the whole output of heavy plates is quickly absorbed. Business in heavy joists and structural steels is quiet and the constructional engineers in the Manchester district, generally speaking, are not actively engaged. On the other hand, there is a big demand for the lighter structural descriptions and during the past week or two consumers' requirements seem to have expanded. The steel works on the North-West Coast are busy and there is heavy production of bars and hoops. The demand for bars has been particularly noticeable. There is also a strong demand for special steels.

North-East Coast and Yorkshire

All the steel plants on the North-East Coast have now fully resumed operations following the holiday period in this district. As a matter of fact production at most of the plant on Teesside continued at a fairly normal rate. Some plant was stopped to undertake much-needed repairs, but the majority of the steel works were kept in active operation. In this district it is maintained that these facts disprove the widespread rumours that the British iron and steel industry has latterly entered a phase of quieter activity. At the moment, certainly, the Iron and Steel Control does not seem prepared to encourage non-essential civilian business; its recent measures have had the effect of speeding up deliveries to the war factories, and presumably it will have more business to allocate in the near future, so as to relieve the makers of anxiety regarding the scale of operations later. The sheet mills on the North-East Coast do not appear to have taken advantage of the opportunity of a holiday, which suggests that they are still well booked, whilst the local re-rolling plants are actively occupied. Heavy structural steel remains a quiet section of the market, but there is an excellent call for shipbuilding steel, including plates in particular, whilst the locomotive builders and the collieries are good buyers of their own specialities. Although there has been a reduction in the imports of semis, this does not appear to have affected the position of the consuming works, and production in all branches has been well maintained. There is a particularly heavy request for alloy steels from the munition makers and comparatively large quantities are being used. Business in bars of all sizes is maintained at a high level and the engineering industry is taking up considerable tonnages of special steels.

Copper and Tin

The copper position in Great Britain is regarded as quite satisfactory and the Control seems to have somewhat relaxed its rigid attitude. Not only are those works employed on Government contracts receiving full supplies, but it is understood that in some cases stocks have been built up against emergencies. In spite of the rather easy position, however, firms who are not engaged on work of national importance do not find it easy to get all the metal they require. In the United States the control exercised by the Office of Production Management appears to be working with great efficiency and the metal is controlled from the raw material to the finished product. According to reports, whilst the domestic price is retained at 12c., in one or two cases the Government have permitted firms to raise their price to 13c., to offset particularly heavy production costs. Whilst there has been no news of further purchases of copper in South American countries by the United States authorities, it is generally thought that the whole South American production is now available for that country. It was expected that Russia would require considerable quantities of copper, but so far there have been no reports of metal having been sent to the Soviet Nevertheless, it is generally thought that copper will be amongst the supplies that will be liberally provided by the Washington authorities. . . . The tin market has been rather lifeless and fluctuations have been small. The view seems to be taken that the production of tin is well in excess of the world's consumption for the time being, but it yet remains to be seen whether Russian requirements will alter this position. Russia could, of course, be supplied direct from the East. Stocks in Great Britain appear to be ample for all needs and there is certainly no shortage of the metal. In the United States the distribution of the metal is carefully supervised and stocks there have increased to about 110,000 tons. In London the price has remained in the neighbourhood of £260, at which level the smelters appear prepared to hedge.

Lead and Spelter

The lead situation in Great Britain is perhaps the most comfortable of all the non-ferrous metals. The Control is not only able to keep the firms engaged upon war work fully supplied, but it is also able to some extent to supply firms engaged upon less important work. In the United States the position appears to be satisfactory, although the stocks there are not large. Consumers who are employed on the rearmaments programme receive all the metal they require through the system of control instituted by the American authorities, and although less is heard of fears of a shortage of the metal, if one should develop it is probable that ample supplies could be obtained from Mexico. . . . The consumption of spelter in Great Britain has been on a heavy scale, although the requirements of the galvanisers are understood to have declined somewhat. In most of the consuming countries of the world, however, a scarcity of the metal is reported, but the British metal industries are obtaining all the supplies they need. In the United States there is a pronounced tightness in the market and apparently efforts are being made to ensure that the firms engaged in the rearmaments programme do not go short of the metal.

Non-ferrous Metal Prices

As in the previous two or three months, the London Metal Exchange official statement shows a fall in the average price for tin. The figures for August indicate a drop of £1 5s. 6d. for cash and £1 8s. 4½d. for three months, compared with the July average. The settlement average is £1 5s. 10d. below that for the previous month. The statement, which includes the official maximum prices for copper, lead, and spelter, is as follows :—

Standard tin	Cash (mean)	£257	3	3
	Three months (mean) ...	£260	1	7½
	Settlement	£257	3	6

The following prices for copper, lead, and spelter are the maximum prices fixed by the Controller of Non-ferrous Metals :—

	£	s.	d.	
Standard copper				
Electrolytic copper ...	62	0	0	delivered buyers' premises
Electrolytic wire bars ...	62	0	0	,, ,,
Best selected copper ...	60	10	0	,, ,,
Lead, good soft pig (foreign)	25	0	0	,, ,, (duty paid)
Spelter, G.O.B. (foreign)	25	15	0	delivered buyers' premises (duty paid)

Notes and Memoranda

Rail and Road

ELECTRIFICATION IN SPAIN.—The electrification of the line leading north out of Madrid, work on which was entirely suspended during the Spanish civil war, is now being seriously delayed for lack of materials. Construction materials acquired prior to 1936 were appropriated or destroyed during the civil war. Of copper there is actually a shortage of 1500 tons.

SWEDISH RAILWAYS ELECTRIFICATION.—Statistics recently published in Sweden show that 2421 route miles of the Swedish State Railways had been electrified by January, 1941, and although this length formed approximately only 40 per cent. of the total route mileage of 6050, the traffic handled electrically amounted to 90 per cent. of the total. Of the private lines, only 375 route miles out of a total of 4320 were electrically worked.

TYRES FOR MOTOR VEHICLES.—The Minister of War Transport has urged all owners of motor vehicles to look to their tyres and to make them last as long as possible. New tyres are wanted in increasing numbers for the fighting services and the supply for civilian purposes during the next twelve months is likely to be considerably shorter than usual. Apart from neglect of such details as correct inflation and the removal of embedded stones, the life of many tyres is shortened by running them to destruction. The longest mileage from tyres is obtained by removing them for remoulding or retreading whilst they are still in a suitable condition and before the wear on the casings is too heavy.

CHINESE RAILWAY PROGRESS.—The latest information from Chungking, according to the *Railway Gazette*, states that a further section of the Yunnan-Szechwan Railway, from Chuching to Hsuanwei, is now open for traffic, so that it is already possible to travel by train from Kunming to Hsuanwei, a distance of 155 miles north-eastwards from the capital of Yunnan. Hsuanwei marks the end of the comparatively easy country traversed from Kunming north-eastwards, and difficult construction again has to be faced between Hsuanwei and Weining, a distance of about 70 miles. The line onwards to Suifu—known sometimes as Iping—is reported to traverse a mountainous area rich in coal and copper deposits.

Air and Water

DUTCH MERCHANT SHIPS IN ALLIED SERVICE.—It has recently been stated that Netherlands merchant ships totalling 3,000,000 tons sail the Seven Seas in the Allied cause. From British ports alone there operate 1,000,000 tons of Dutch shipping manned by 8000 seamen whose homes were in Holland. The Netherlands Shipping and Trading Committee, in close co-operation with the Admiralty, controls these ships.

PANAMA CANAL TRAFFIC.—During the month of June traffic passing through the Panama Canal totalled 290 ocean-going ships paying tolls of 1,064,330 dollars. This is the smallest volume of transits for many years, and compares with 369 vessels, paying tolls of 1,428,249 dollars, in June, 1940. For the fiscal year ended June 30th last a total of 4727 seagoing ships passed through the canal, tolls amounting to 18,157,739 dollars. This compares with 5370 ships, paying tolls of 21,144,675 dollars, in the fiscal year 1939–40.

AMERICAN CARGO SHIPS.—The U.S. Maritime Commission has placed a contract with the Pusey and Jones Corporation, of Wilmington, for ten "C-2" type cargo ships at a total estimated cost of over 22 million dollars. In announcing the contract the Corporation stated that the work will necessitate additional men, bringing the yard's personnel up to 2300—the highest in its history. The construction programme will keep the yard at full capacity until the middle of 1944. The "C-2" ships to be built are about 450ft. long with a deadweight tonnage of 9500.

IRISH LIFEBOAT STATION.—The Royal National Lifeboat Institution has established a new lifeboat station on the west coast of Ireland, at Killybegs, in Donegal Bay, and a motor lifeboat has now arrived there. She sailed from England under the command of the Institution's district inspector for Ireland, manned by a crew from Killybegs. Her journey of nearly 500 miles took nine days. The lifeboat is one of the most powerful type in the R.N.L.I. fleet, and can proceed 128 miles at full speed without refuelling. She has radio telephony receiving and transmitting sets, a cabin, searchlight, line-throwing gun and an oil spray. She can take 100 people on board.

TRANS-TASMAN AIR SERVICES.—Figures for the year ended March 31st last reveal record achievements by Tasman Empire Airways. Of 134 trips scheduled 130 were completed—97·01 per cent. of the possible—an exceptionally high proportion for ocean crossings over a period of twelve months. All the trips were made by the "Aotearoa" and "Awarua," which carried a total of 1461 passengers. The hours flown amounted to 1180·48, an average of 9·08 hours per trip. The quickest flight was 6 h. 57 min. on March 23rd. The aggregate of miles flown was 174,200, computed on the airline distance of 1340 miles between Auckland and Sydney. The mile in this calculation is the standard statute mile (1760 yards). Other figures for the year under review are: Freight carried, 14,448 lb.; mails carried, 77,571 lb.; baggage carried, 33,817 lb.; passenger miles, 1,957,740; freight ton-miles, 8644; mail ton-miles, 46,402.

DISCHARGE OF AIRCRAFT WORKERS.—The Ministry of Aircraft Production, in a statement explaining why, with an ever-increasing output of aircraft, it happens that at some factories a number of workpeople are being discharged, says that the maintenance of the superiority of the R.A.F. over the German air force depends on a continuous process of improvement in types. The diversion of a factory or part of it to the production of a new type requires the setting aside of floor space for new jigging and tooling, and this inevitably means that a percentage of the workpeople become for the time being redundant. It is so vital that every available workman should be employed fully on war production that it is necessary to transfer labour thus made redundant to other war work without delay, and they are immediately placed in fresh employment, so far as possible, in the neighbourhood of their homes.

RUSSIANS IN AMERICA.—A party of forty-seven Russians, including aeroplane pilots, mechanics and wireless operators led by Mikhail Gromov, who was chief pilot of the Russian aeroplane that made a non-stop flight from Moscow to California in 1937, recently arrived in the United States, having come by air *viâ* Nome in Alaska. They intend to study American methods of aeroplane manufacture.

A "FLYING FORTRESS" IN ACTION.—During the raid on the German warships at Brest on August 16th a "Flying Fortress" bomber engaged in the first encounter which an aircraft of this type has had with enemy fighters. Shortly after it had discharged its bombs two "Heinkel 113's" and five "Messerschmitt 109Fs" attacked it repeatedly from both sides and from dead astern. The fight lasted for twenty minutes, when our machine reached a low patch of cloud and the enemy broke off the engagement. Some of the crew were killed and others wounded and the "Fortress" was severely damaged. The gangway from the pilots' cabin to the rear was blocked by a tangled mass of wires and cables, the flaps were out of action, the tail tabs had been shot away, the bomb doors were wide open, the tail wheel was stuck half up and half down, the brakes were not working, only one aileron was serviceable and the rudder was scarcely controllable. Nevertheless the captain of the aircraft succeeded in bringing it back and landed it safely in an aerodrome which was not only strange to him but a little too small for a machine of the size of a "Fortress."

Miscellanea

IRIDIUM FOR PLATING.—It is reported that an American metallurgist has succeeded in devising an indium sulphate plating bath for the application of smooth, matte deposits of the metal.

NEW AMERICAN PIPE LINE.—A Reuter message states that a joint plan for a 1820-mile oil pipe line system has been submitted by eleven oil companies to Mr. Harold Ickes, Petroleum Defence Administrator in America. The system would be capable of delivering 250,000 barrels of oil daily into the New York area from the South-West.

OLD TUBES FOR PIT PROPS.—South Africa is using discarded steel tubes for making pit props. Tubes of suitable diameter—4in. is one diameter mentioned—are filled with concrete. Bands are welded round the ends to prevent bursting of the tubes and to prevent the concrete becoming loose in the tube pins are inserted through them near the end when filling, or by welding caps or bands over the ends.

RUMANIA'S IRON.—By the occupation of Rumania by Germany that country has gained control of eight blast-furnaces, of which four are in operation. Two belong to the Recitza works and two to the State Ironworks at Hudorra. The German authorities propose to modernise the industry and, to make effective use of the local low-grade iron ores, they may erect four or five Krupp furnaces of a capacity of 30,000 tons each.

TUNGSTEN FOR WAR.—Stimulated by defence activities, the American production of tungsten ore and concentrates in 1940 increased 42 per cent. over 1939. Shipments from domestic mines, which were 24 per cent. more than in 1939, were not only the largest since 1917, but have been exceeded in only one other year—1916. In 1940, 5319 short tons of concentrated ore (reduced to an equivalent of 60 per cent. WO_3) were shipped from United States mines, compared with 4287 tons in 1939.

TUNGSTEN FROM TAILINGS.—Salvage from re-use of old materials is only part of the scheme to save several million tons of tailings containing a fraction of 1 per cent. of tungsten which have accumulated at an America mill, and are now being subjected to retreatment by classification and grinding. This is believed to be the first installation in the United States of this type of control on the flotation process and it makes possible the recovery of a large tonnage of strategic metal not otherwise available.

RESEARCH IN AMERICA.—An office of Scientific Research and Development has been created by President Roosevelt, as a part of the Office for Emergency Management of the Executive Office of the President. The work of the organisation will be to co-ordinate medical and scientific research of various Government agencies, to serve as a centre for mobilising scientific resources of the nation, to develop broad plans for scientific research in the defence programme and to initiate special defence research projects.

SPHERICAL GASHOLDERS.—A gas undertaking in Cleveland, Ohio, has put down three arc-welded alloy steel spheres 57ft. in diameter and 70ft. high overall. Each sphere has a storage capacity of over 50,000,000 cubic feet. Each sphere is, in reality, two spheres in one. Within an outer shell and separated from it by 3ft. of cork insulation is a nickel alloy steel sphere in which the gas is actually stored. This inner sphere actually "floats" upon the cork insulation, a feature which allows "working" during expansion and contraction. Most of the work is welded.

DIAMOND DRILLING BITS.—In a note on diamond bits for drilling in mines a South African expert points out that what is known as the impregnated bit is not self-sharpening in the same way as an ordinary grinding wheel. Should drilling conditions, such as rock hardness, drilling speed and pressure, be such that the boart grains in the bit polish before completing their useful life, the bit can be reconditioned by blasting the bit face in a high-velocity jet of silicon carbide particles; this treatment erodes the boart grain surfaces slightly and cuts back the bond to give the boart grains more relief.

RUSSIAN GOLD.—Soviet metallurgists claim that their country is now the second largest producer of gold, South Africa alone beating it. Russian gold production rose steadily from 1,291,000 oz. in 1907 to 1,984,000 oz. in 1914. Since when official figures have not been made public; it has been estimated, however, that the output of the U.S.S.R. in 1939 reached a total of 5,000,000 oz. To-day the Government controls the industry by two methods. One of these is by means of a large State organisation which has been developed on a communal basis. The other method of control is by compelling all the small private companies to sell their entire output to the State.

COKE IN RUSSIA.—There is plenty of low-grade coal in Russia, to utilise which Soviet scientists are reported to be working out a method for the industrial production of high-grade coke for smelting purposes. A commission, headed by Professor M. A. Pavlov, has been carrying out experiments during the last two years at the Magnitogorsk Iron and Steel Works in the Urals with low-grade coal obtained from the deposits in the eastern and southern parts of the Soviet Union. Experts have designed an apparatus with which to determine the behaviour of coke in the blast-furnace, and have worked out a new system for rating coke. The apparatus, it is claimed, also makes it possible to control the technological *régime* during the process of smelting, to increase the productivity of blast-furnaces and to improve the quality of coke.

FUEL ECONOMY.—The Mines Department has sent a letter to Government Departments, including the Service Departments, drawing their attention to the urgent national need for exercising the strictest economy in the use of all fuels, whether for heating or lighting. Asking these departments to set an example in fuel economy—the fuels include coal, coke, gas, electricity and paraffin—the Mines Department says: "When the public is asked to put up with inconveniences in the national interest, it is essential that there should be the fullest evidence that Government Departments and, indeed, all large-scale consumers are themselves giving the lead in the matter." All the industries concerned with fuel supplies are co-operating to make the scope of this campaign nation-wide; special appeals are being addressed to hotels, restaurants, clubs, offices, blocks of flats and stores, as well as to households.

Personal and Business

SIR WALTER ST. D. JENKINS has joined the board of Sentinel Waggon Works (1936), Ltd.

MR. R. J. BARCLAY has been appointed managing director of Markham and Co., Ltd., of Chesterfield.

WE record with regret the death on active service of Lieut.-Colonel Sir Edmund Keith Nuttall, Bart., chairman of Edmund Nuttall, Sons and Co., Ltd.

SIR ERNEST LEMON, vice-president of the London Midland and Scottish Railway, has been appointed president of Associated British and Irish Railways, Inc.

MR. G. H. INCE, Director-General of Man Power, Ministry of Labour and National Service, has been appointed to represent that Ministry on the Central Council for Works and Building.

THE HAROLD ANDREWS GRINDING COMPANY, Ltd., cylinder liner makers, of Bournbrook, Birmingham, is opening a number of branch offices in various large towns, the first being in London at 208, Fulham Palace Road, Hammersmith, W.6.

THE Ministry of Supply announces the following appointments:—Mr. C. L. Dyer, Director of Tank Materials and Construction; Mr. C. B. Cowley, Director of Tank Components; and Mr. J. D. Crozier, Co-ordinating Director and Principal Advisory Engineer to the Director-General of Tank Supply.

WE record with regret the death of Mr. W. R. Hutton, general manager of R. and W. Hawthorn, Leslie and Co., Ltd., of Hebburn-on-Tyne. Mr. Hutton was born at Stirling in 1876 and served his apprenticeship with Barclay, Curle and Co., Ltd. He became shipyard manager at Hebburn in 1907 and was appointed general manager in 1919.

THE FRANCOIS CEMENTATION COMPANY, Ltd., Bentley Works, Doncaster, has changed its name to the Cementation Company, Ltd. The management of the company is entirely British and out of its large number of shareholders only five members, holding between them £338 out of the total issued capital of the company, viz., £322,500, are of foreign nationality and registered abroad. Whilst this fact has been well known to the older clients and suppliers of the company, it had become evident to the board of directors that newer clients and suppliers were sometimes misled by the name "Francois" in the title, and they have therefore considered the change of name of the company desirable at this present juncture.

Forthcoming Engagements

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Monday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

Institution of Electrical Engineers

Thursday, September 18th.—Installations Section. Savoy Place, Victoria Embankment, W.C.2. Chairman's Address, H. T. Young, and "Space Heating by means of Electrically Warmed Floors as Applied to Surface-type Air Raid Shelters," R. Grierson. 6 p.m.